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Abstract

This report is designed to investigate the potential for prepaid electricity plans to operate as energy efficiency within Minnesota's conservation improvement programs. Like prepaid cell phone customers, prepaid electricity customers pay for service in advance of receiving it. When customers' prepaid credit runs out, their electricity is remotely turned off at the next legally permissible time (usually following a short grace period and low-balance warning, often not during specific times like extremely hot or cold days). This differs from the current standard payment plan in many respects and remains controversial among key stakeholders.

We conducted a literature review, program evaluation analysis, stakeholder interviews, and a simulation of potential Minnesota-specific scenarios.

Customers on prepaid electricity plans likely use less electricity than they would otherwise. On average, the estimated electricity usage reduction is approximately 9%, with six evaluations suggesting savings under 7%, one (a small sample study) finding nonsignificant reductions, and five suggesting reductions of more than 10%. This suggests that prepay programs influence energy use, but more research is necessary to determine the degree of influence and to rule out alternative explanations. In particular, many of the evaluations included savings from residential power being shut off,[1] and most evaluations could not adequately control for self-selection bias. More research is needed regarding the actions that households take to reduce consumption and whether or not those actions lead to deprivation.

Mindful of these caveats, we estimate that Minnesota prepay participants could reduce their consumption by 8.5% in a standard prepay program, or 2% in a program that includes a key consumer protection: removal of automatic shutoffs. These are fragile estimates. Research to date includes only programs with automatic shutoff and does not address whether elements that are not unique to prepay, such as enhanced motivating feedback, are responsible for most of the savings. Therefore this report offers a framework for interested utilities to design a prepay pilot program that can answer these important questions while addressing consumer protection concerns.

[1] Some stakeholders argue that energy reductions from disconnection should be included as savings because disconnections could be used as a deliberate action to control usage. We do not agree. Evidence is insufficient to state that most customer disconnections occur deliberately, without affecting quality of life. Customers using prepay could deliberately self-disconnect without experiencing deprivation, for example while traveling, but in current evaluations, this type of disconnection has not been accounted for separately from other disconnections. Based on our research, we tentatively conclude that most self-disconnection occurs while customers are at home and represents some degree of deprivation as opposed to efficiency behavior (conservation). More research on this question could change this conclusion.

Table of Contents

List of Tables

Definition of Terms and Acronyms

AMI: Advanced metering infrastructure

Arrears: Money that is owed and should have been paid earlier

CIP: Conservation improvement program

Conservation: The act of reducing energy consumption without reducing quality of life

Deprivation: A reduction in quality of life

DEFG: Distributed energy financial group

Energy efficiency investment: The act of reducing energy consumption by purchasing physical devices or home upgrades

Energy efficiency behaviors: An umbrella term referring to both conservation and energy efficiency investment

GWh: Gigawatt hours

IOU: Investor-owned utility

kWh: Kilowatt hours

LIHEAP: Low-income home energy assistance program

NCLC: National consumer law center

Quality of life: A combination of a person's subjective and objective life circumstances, including both subjective measures of well-being and satisfaction and objective measures of health, costs of living (relative to income), and other factors.[2]

[2] Authors such as Diener and Suh (1997) cite these measures as potentially useful for measuring quality of life. We recognize the ongoing debate among health researchers regarding this term.

Executive Summary

Overview

Prepay electricity plans require customers to pay for their electricity in advance of receiving service. These plans reconceptualize the electricity provision system and turn it from a service paid for after the fact to a service paid for in advance. This program model is controversial because low-income customers represent a sizable proportion of participants in such programs, and consumer advocates have raised concerns regarding potential negative effects on this vulnerable population. Nevertheless, prepay advocates suggest that these programs could reduce electric consumption while increasing utility revenues and customer satisfaction. To determine the potential in implementing prepaid electricity plans as energy efficiency programs in Minnesota, we set out to answer eight research questions:

1. What is the history and prevalence of prepaid electricity programs?
2. Why is prepay implemented?
3. What are the potential usage reduction impacts of prepaid electricity?
4. What might be the usage reduction potential from prepaid programs in Minnesota?
5. What are the considerations of prepay advocates and opponents regarding prepay programs?
6. Which elements of prepay cause the reduction in energy use?
7. Is the reduction in consumption a result of energy efficiency behavior (i.e., conservation), home upgrades, or deprivation?
8. What is a recommended framework for establishing a prepaid electricity program in Minnesota?

Background

Prepay electricity plans allowing multiple payment options have existed since the 1980s and are prevalent in many areas of the world. In Minnesota, only one utility (an electric cooperative) currently offers a prepaid electricity option. Another Minnesota utility previously offered a prepay plan option that they have since discontinued due to concerns from consumer advocates and regulators. A third utility recently filed to include a new pilot program in their energy efficiency portfolio, but the program was rejected by the Department of Commerce.

Prepay electricity plans typically differ from traditional postpay plans in several ways: payment arrangements, energy consumption feedback, disconnection, and overall costs. A number of these features could, in themselves, reduce energy consumption and may be applied to current postpaid plans. Others could be eliminated from prepaid plans to increase consumer protections, but the energy savings impacts of doing so are yet unknown.

Methods

We conducted this study in five steps: a literature review, a summary and assessment of program evaluations, interviews with stakeholders and experts, calculation of potential Minnesota energy

savings, and framework development for utilities to create prepaid electricity pilot programs that address consumer protection issues and answer key research questions.

Results

Customers on prepaid electricity plans likely use less electricity than they would otherwise. On average, the estimated electricity usage reduction is approximately 9%, with six evaluations suggesting savings under 7%, one (a small sample study) finding nonsignificant reductions, and five suggesting reductions of more than 10%. This suggests that prepay programs influence energy use, but more research is necessary to determine the degree of influence and to rule out alternative explanations. In particular, many of the evaluations included savings from power being shut off, and most could not adequately control for self-selection bias.[3] More research is needed regarding the actions that households take to reduce consumption and whether those actions lead to deprivation. One report examined the persistence of savings and noted that energy reductions from prepay continued during the programs but also diminished over time.

Stakeholders and experts we interviewed raised a variety of concerns regarding prepaid electricity. These included a need for additional research to address unanswered questions, customer and consumer protection issues (especially for low-income customers), and uncertainty about utility costs and savings. Of these, possible consumer deprivation resulting from more frequent shutoffs was the most commonly cited issue. However, prepay advocates note that current postpay plans are also imperfect. They allow customers to accrue arrearages, and if shut off, the power outage is longer and more difficult to remedy. Nevertheless this report examines prepaid electricity specifically and whether it can reduce electricity use without causing deprivation. Stakeholders generally agreed that more research was required on this and other consequential topics. The state regulatory decisions outside Minnesota that we reviewed revealed a common concern by regulators regarding consumer protections.

A significant issue of whether prepaid electricity plans should be considered energy efficiency programs also remains. Most existing prepay plans we reviewed were proposed as programs to provide customer bill payment alternatives, not as energy efficiency programs. Importantly, based on the Minnesota definition of energy efficiency, a prepay electricity program would not be considered efficiency if it reduces “the quality or level of service provided to the energy consumer.”[4]

Prepay customers sometimes pay more for electricity than postpay customers and tend to go without electricity more often. However, in surveys by prepay program administrators and university

[3] Some stakeholders argue that energy reductions from disconnection should be included as savings because disconnections could be used as a deliberate action to control usage. We do not agree. Customers using prepay could potentially deliberately self-disconnect without experiencing deprivation, for example while traveling, but in current evaluations, this type of disconnection has not been separated from other disconnections. Based on our research, we tentatively conclude that most so-called self-disconnection occurs while customers are at home and, as such, represents some degree of deprivation. More research on this question could overturn our conclusion.

[4] We have been informed that some utilities are considering packaging structural energy efficiency measures with prepaid electricity plans but, as yet, do not have details of these plans.

researchers, most prepay customers reported being satisfied with their plans (and sometimes preferred them to postpay). Minnesota regulators or legislators will have to decide whether these programs cause consumer deprivation and/or a reduction in quality of service to determine whether they may qualify as energy efficiency measures.

Leaving aside the issue of whether usage reduction is energy efficiency, we estimated the total potential electricity usage reduction impact of prepaid electricity in Minnesota. To accomplish this, we developed two scenarios, one in which the program follows current norms (including automatic disconnect shortly following a zero balance) and the other with no disconnection threat (i.e., customers move back to a traditional payment plan when their balance is zero or have some other incentive for avoiding a $0 balance). Programs without disconnection have been proposed but, as yet, have not been piloted. We present annual energy savings estimates and assumptions for each scenario in Table 1.

While these estimates represent our best judgement of relevant data and how they may apply to the Minnesota landscape, we emphasize that they are based on a limited data set that often includes a large proportion of low-income and payment-challenged customers. In addition, more research is needed to estimate savings potential under different scenarios (e.g., to understand potential energy reductions if the program design had no disconnection threat). In the second scenario, with no threat of disconnection, we hypothesize that through high levels of customer feedback and engagement, we would still see energy reduction as compared to traditional postpay plans (but less than from standard prepay plans). This is an area where further research would strengthen the accuracy of the estimates in Table 1.

Table 1. Annual energy savings estimates and assumptions

Scenario	Baseline residential energy consumption (GWh)	Annual usage reduction	Total potential statewide usage reduction (GWh) [5]
Customers can be disconnected after payment lapse	10,627	8.5%	9 GWh
Customers will not be disconnected after payment lapses but will be moved to traditional payment plan	10,627	2%	2.1 GWh

[5] This assumes a 1% participation rate. See the Estimating Impacts section of the report for details.

Recommendations

We offer a framework to utilities interested in designing prepaid electricity pilot programs that would help fill the knowledge gap while addressing consumer protection concerns.

Programs that fully address potential consumer deprivation may reduce potential energy savings (e.g., by eliminating threat of remote shutoffs). Consumers (especially low-income customers) will be better protected, but electricity savings may decrease or become nonsignificant. Our recommended pilot program design framework specifically addresses this possibility. We recommend using several alternative treatment groups (in addition to standard postpay control groups), quasi-experimental methods, and creative sampling strategies.

Conclusions

Previous evaluations suggest that electricity consumers use less electricity when on a prepaid electricity plan. However, this observed usage reduction may in part be due to factors that reduce customer quality of life, such as going without electricity more often. We do not argue that customers on prepay necessarily experience more deprivation than those on postpay plans. Those on postpay plans that accumulate large arrearages and experience extended disconnections may have equal or diminished quality of life and greater deprivation than those on prepay. Rather we note that one factor that may strongly motivate behavior change (threat of fast disconnection) may also reduce quality of life and, thus, may be integral to the program's electricity reductions. Therefore more research on the cause of electricity reductions in prepay programs is necessary.

We also note that further research may highlight elements of prepaid electricity plans that are not unique and may account for a substantial proportion of the energy savings. In particular, advanced real-time feedback about electricity use, along with metrics and messages that motivate behavior change, could be one such key factor.

Introduction

The state of Minnesota's Next Generation Energy Act (2007) established the importance of cost-effective energy reduction.[6] The act focused on energy conservation as the primary strategy for meeting this goal and established an energy use savings target of 1.5% (electricity and natural gas) each year through cost-effective conservation improvement programs. The Minnesota Department of Commerce, Division of Energy Resources sponsored this white paper to examine the viability of prepaid electricity services as a potential energy efficiency program that could help conservation improvement programs reach their annual savings targets.

To examine potential program savings, we addressed whether customers using prepaid electricity reduce their electricity consumption and, if so, whether this reduction can be considered energy efficiency.[7] To do this, we examined the potential of prepay programs to change behavior, attempted to determine which behaviors might be changed, and assessed which elements of the program might cause that change.

The question of whether prepaid electricity payment plans should be considered energy efficiency programs hinges on more than whether the programs reduce consumption.[8] Minnesota's statutory definition of energy efficiency requires that the measures or programs save energy "without a reduction in the quality or level of service provided to the energy consumer." Consumer behaviors that are changed, the subjective experience of the participants, and the objective outcomes for those participants dictate whether the program causes energy savings through energy efficiency behaviors (i.e., conservation or energy efficiency investment) or deprivation (see Glossary for definition of these terms). Minnesota should not consider a program that causes deprivation to be an energy efficiency program. In the section Prepay Considerations from Opponents and Advocates, we examine the research on the deprivation question and suggest future research avenues.

A small number of states and utilities recently proposed prepaid electricity as an energy efficiency measure. Because of the limited implementation to date, empirical evaluations of prepay's effectiveness to reduce energy consumption are few. We therefore combined our review of program evaluations, academic literature, regulatory decisions, and other non-peer-reviewed reports with interviews of key actors and stakeholders who are familiar and/or involved with prepay electricity programs. With this complete picture of programs, literature, and interviews, we were able to distill the current state of

[6] The details of the Next Generation Energy Act can be found on the Minnesota government website.

[7] Minnesota defines energy efficiency as follows: *Energy efficiency* means measures or programs, including energy conservation measures or programs, that target consumer behavior, equipment, processes, or devices designed to produce either an absolute decrease in consumption of electric energy or natural gas or a decrease in consumption of electric energy or natural gas on a per unit of production basis without a reduction in the quality or level of service provided to the energy consumer. The full definition can be found on the government website.

[8] We use the term *prepay plan* to indicate a payment option and *program* to indicate a strategy to change behavior, such as an energy efficiency program. Minnesota regulators and legislators may wish to decide whether prepay plans should be considered conservation improvement programs.

knowledge and identify ideas for future pilot programs and empirical research on prepay as energy efficiency.

Importantly, this report takes examples from national and international programs and combines them with Minnesota-specific interests, cultures, and requirements. We propose Minnesota-specific recommendations and estimate potential savings for Minnesota prepaid electricity programs using assumptions derived from our research.

Key Research Questions

This research report serves to answer key questions to help Minnesota decide whether the state should incorporate prepaid electricity plans into the Minnesota Conservation Improvement Program (CIP):

1. What are the history and prevalence of prepaid electricity programs?
2. Why is prepay implemented?
3. What are the potential usage reduction impacts of prepaid electricity?
4. What is the usage reduction potential from Minnesota prepaid programs?
5. What are the considerations of prepay advocates and opponents regarding prepay programs?
6. Which elements of prepay cause reduction in energy use?
7. Is the reduction in consumption a result of energy efficiency or deprivation?
8. What is a recommended framework for a prepaid electricity program in Minnesota?

This report provides answers to these questions using previously gathered reports and studies, along with interviews with key stakeholders. In some areas, our analysis and recommendations are limited due to a lack of strong research and pilot program evaluations.

Structure of this Report

This report begins with a basic description and background of prepaid electricity plans (highlighting Minnesota context) and then continues with four primary sections. The first section, Prepaid Electricity Impact on Energy Use (along with Appendix E), is an analysis of currently available evaluations of energy reductions from prepaid programs. In this section, we also delve briefly into what elements of the prepay plans may cause changes in behavior (with more details provided in Appendix B). The second section, Prepay Considerations from Opponents and Advocates, discusses why utilities usually offer prepay plans, why some stakeholders may be concerned, and what regulatory bodies have decided regarding prepay proposals. The third section, Potential Energy Efficiency Impacts of Prepay in Minnesota, is a calculation of potential energy reductions from prepaid programs in Minnesota. The last section, Recommendations, provides a framework for utilities interested in implementing a prepaid pilot program.

Prepaid Electricity: Background

Prepay electricity plans, like prepay cellphone plans, require customers to pay in advance of receiving service. When customers' prepaid credit runs out, their electricity is remotely turned off at the next legally permissible time (usually following a short grace period and low-balance warning, often not during specific times like extremely hot or cold days). Conversely, electricity is immediately restored when the customer purchases additional credit. This differs from the current standard payment plan in many respects. Although customers purchase other necessities in advance of use, such as groceries or gasoline, using this system for electricity remains controversial.

Although plans vary, prepay electricity plans typically differ from postpaid plans in several characteristics. The differences that may be relevant for affecting behavior are summarized in Table 2.

Table 2. Comparison of prepaid electricity plans and postpaid plans

Characteristic	Prepaid plan	Postpaid plan
Payment arrangements	Customers pay for their electricity before using it. Newer programs allow paying for credit using a variety of payment systems.	Customers typically pay for their electricity *after* using it, usually with a delay of about three weeks to two months. Paying in advance rarely occurs. Most programs allow for payment using a variety of payment systems.
Feedback on energy consumption	Customers receive frequent feedback about their electricity use.	Customers typically receive feedback infrequently, usually in monthly bills (which may be ignored if a customer subscribes to autopay). Sometimes customers also receive home energy reports from a third party. This varies depending on the utility.
Rapid disconnection	Customers are remotely shut off from electricity services shortly after running out of credit. This usually follows a short grace period, and often not during restricted times that mirror restrictions for postpay (e.g., extreme weather days).[9]	If customers do not pay their bills, they can accumulate arrears for a longer period before being shut off. Customers receive multiple written warnings and often cannot be disconnected during restricted times (e.g., extreme weather days or extended heating/cooling seasons).

[9] As with postpay plans, if power was disconnected before these times, it will not be reconnected during these events. To our knowledge, two programs have proposed returning customers to postpay after a grace period of a few days, rather than disconnecting them. However they have not been approved by regulators.

Characteristic	Prepaid plan	Postpaid plan
Costs and deposits for initiating services	These vary among plans. Sometimes prepay plans offer lower fees (or no fees) for connection or reconnection of electricity services, relative to postpay. Sometimes prepay plans require no deposit (or reduced deposit) for initiating service.	Postpay plans often require a deposit or credit card before service can be initiated.
Rate structure and overall costs	Prepay plans generally have different rates and fees than postpay plans. Sometimes various fees are waived. In other cases, programs add equipment rental fees, access charges, transaction fees (e.g., for credit card payments), or mandatory repayment of existing arrearages. Sometimes, prepay customers can receive the same access to time-of-use rates as postpay customers. American prepay kWh rates are not usually lower than postpay rates.	Postpay plans often have tiered or time-of-use rate designs that are different from prepay. In the United States, overall costs are usually the same or lower than prepay, but they are somewhat comparable. When utilities charge transaction fees for certain payment methods, customers using those methods who are paying only once per month will have lower overall costs than those paying more frequently.

History and Prevalence of Prepaid Electricity

United Kingdom utilities are credited with the earliest versions of prepaid electricity plans, using coin-operated electricity systems in the early 1900s. In 1988, South Africa's Eskom public utility operated the first prepaid electricity plan that allowed more payment options. That plan, and others that followed, used cards, keys, or key codes that could be recharged at a kiosk or over the phone (Esteves et al. 2016). Following the South Africa program, utilities rolled out prepaid electricity plans throughout other regions of Africa, Europe, South America, Asia, and more recently, North America.

In this way, prepaid electricity plans became a common electricity payment method in many countries. In Mozambique, 80% of customers in 2011 used prepay meters (Esteves et al. 2016). In South Africa, approximately 4.3 million electricity customers use prepay.[10] In China, an estimated 34% of customers across all provinces and urban/rural districts use prepay (Du, Guo, and Wei 2017). New Zealand, India, and Argentina are also leading countries in terms of prepaid usage (Oseni 2015). In all these cases, prepay electricity began as pilot projects that grew slowly over 10 to 20 years into established programs that are now widely accepted as a common form of electricity payment.

Prepay is also a prevalent form of bill payment in many European countries. In the United Kingdom, 16% of electricity consumers subscribed to a prepaid program in the first quarter of 2018, including 38% of

[10] Eskom data on its prepay customers in South Africa are available on the Eskom website.

customers in Northern Ireland (Ofgem 2018). These regions have prepay consumers from all income brackets (Oseni 2015).

Prepay electricity programs in the United States have grown in number over the past decade. The Distributed Energy Financial Group (DEFG), a management consulting firm that focuses on energy and has promoted prepay electricity, maintains a database of prepaid programs across the country. In 2018, the DEFG database included 17 prepaid electric utility programs with the status "pilot" or "full scale," 12 programs with the status "planning," three with "canceled" or "suspended," and seven that are unknown (and not public), for a total of 40 programs (N. Treadway, Managing Partner, DEFG, pers. comm., July 12, 2018). Most of these programs launched after 2009, while one launched in 1998.

North American programs rely on advanced metering infrastructure (AMI)—also known as smart meters—which is more powerful and flexible than earlier keypad, card, or key code prepay systems. AMI allows utilities to track customer use and provide real-time feedback over multiple personal devices. Other technological advances also allow customers to add account credit online or via other methods.

Around the world, low-income customers are enrolled in prepaid plans more frequently than customers in other income brackets (e.g., Boardman and Fawcett 2002; Brutscher 2012; Darby 2010; Graham and Marvin 1994; Howat and McLaughlin 2012). Although other demographics may be a potential future market for prepay in North America (e.g., tech-savvy millennials; Wimberly 2018), this is currently also true in the United States. Among programs that have disclosed customers' income information, low-income consumers usually compose the largest group of enrolled customers in prepaid plans (e.g., APS 2015; Doble 2010).[11] In some regions, such as the Netherlands, Ghana, and some areas of the United States, utilities market prepay to all income levels, but low-income customers are nevertheless the primary participants (Azila-Gbettor, Atatsi, and Deynu 2015; Esteves et al. 2016; APS 2015). Therefore when considering whether prepaid electricity plans are behavior-change programs, implementers should pay attention to impacts on this customer class in particular.

Prepay Programs in Minnesota

Minnesota Valley Electric Cooperative (MVEC) is the only Minnesota utility that currently offers customers an option to prepay their bills. Their program, called "PayGo," allows customers to pay smaller daily and weekly increments. Customers also have an option to add account funds to cover their electric needs for months in advance. According to MVEC, approximately 400 of around 40,000 members (i.e., customers) are part of this program. The utility's website reports that nearly all (95%) the 400 MVEC members in the PayGo program said it allows them to fit their electric bill more easily into their monthly budget. In addition, when asked about their energy usage, 59% of MVEC PayGo members said their electric costs were noticeably lower. However this value was self-reported and these findings have not been independently evaluated to demonstrate energy savings. MVEC offers the PayGo payment option to a small number of customers as an alternate arrangement to monthly billed

[11] Most utilities in the United States with prepay programs have small programs and either do not collect or do not share data on the income levels of their participants. Nevertheless, based on available data and interviews with prepay experts, it is reasonable to believe the United States is similar to other countries in that prepay customers are more likely than non-prepay customers to be low income.

payments. It is not intended to be an energy efficiency program. Program participants can be disconnected from service if they do not make their payments. However, to prevent surprise, MVEC provides notifications when the account balance is nearing zero (E. Webster, Vice President Corporate Services, MVEC, pers. comm., August 20, 2018).

Nearly 25 years ago, Ottertail Power, an investor-owned utility (IOU) that provides electricity service in Minnesota, had a pilot program for their employees that included a prepayment option. These participants had an in-home device that would take credit card payments. While some customers liked the option, consumer advocates and regulators had concerns, and so the program was discontinued (J. Grenier, Market Planning Manager, Ottertail Power, pers. comm., June 14, 2018).

Recently, MN Power, another IOU in the state, submitted a request to include a prepay pilot in their 2017–2019 Triennial CIP filing. The pilot was described briefly in the filing, including their work with ESource to develop the pilot. However, the Minnesota Department of Commerce ultimately rejected this pilot program because it did not contain enough detail about program design and consumer protection elements (J. Burdette, State Energy Officer, Minnesota Department of Commerce, pers. comm., July 2, 2018).

Methods

We conducted the research and writing of this report in five steps:

1. Conducted a thorough literature review of 30 peer-reviewed academic articles, eight regulatory decisions, and 24 non–peer reviewed reports (from utilities, advocates, consumer rights organizations, and news media organizations)

1) Located, assessed, and summarized 16 prepaid electricity program evaluations, which were described in 10 reports

2. Conducted interviews with 21 different stakeholder groups, including five Minnesota utilities, two prepay implementation companies, six consumer advocate organizations, three organizations that advocate prepay (among other issues), two Minnesota government offices, and three academic researchers working at various universities, summarized the themes from the interviews in Appendix A, and integrated those themes into the report, alongside the literature review, where appropriate

2) Established scenarios for prepaid programs in Minnesota and calculated potential savings from those scenarios

3. Produced framework recommendations, noting where the knowledge gaps resided and how pilot programs could be designed to address these knowledge gaps and provide service that protects consumers

Prepay Electricity Impact on Energy Use

In our search for high-quality electricity consumption evaluations for prepay programs, we found 10 reports containing results from 16 evaluation efforts of varying rigor. Table 3 summarizes information about these program evaluations and Appendix E provides more-detailed explanations (with references). To assess each study and/or evaluation, we sought information on

- The percentage change in electricity use and whether the change was statistically significant
- The evaluation method and what type of control group was used (if any)
- The number of participants
- The length of time participants' energy use was observed before and after enrolling in a prepaid plan
- What participant actions appear to account for reduced electricity consumption
- Whether the savings evaluations excluded time during which customers' power was turned off[12]
- Whether total electricity costs to prepaid program customers were different from those in the postpay control groups[13]
- The year the evaluation was conducted
- The region where the programs were implemented

The reports in Table 3 include statistics and research methods that were used in the evaluated programs. However these varied significantly in their levels of transparency and quality. We rated the quality of evaluations as "acceptable" or "limited." Acceptable evaluations included most of the data we were looking for. Limited evaluations were difficult to assess because they lacked transparency or information (e.g., we were not provided full evaluation reports, but short summaries of the evaluations). More details regarding the evaluation classifications is available in Appendix E, along with specific findings from those evaluations.

[12] Customers turn off electricity service more frequently when enrolled in prepay than when enrolled in postpay (Howat and McLaughlin 2012). Therefore evaluators should calculate how much of the electricity savings (if any) can be attributed to power being completely turned off. To our knowledge, no evaluation has attempted to differentiate between power being off while residents are at home as opposed to away (when it would be less likely to affect quality of life).

[13] In some cases, consumers prepaying for electricity may pay higher electricity costs (rates, transaction fees, enrollment costs, reconnection fees, and so on) than comparison consumers (e.g., Martin 2014). Although consumer price sensitivity is typically low, this could nonetheless be one part of the reason that prepay customers reduce their electricity consumption. Higher costs could take the form of monthly access fees or reconnection fees, but they could also take the form of third-party vendor fees (e.g., charged at a kiosk or for payment by check) that may be incurred more frequently by prepay consumers because they pay for electricity more often. Many programs also include a debt-repayment component in which a portion of top-up credits that are purchased (sometimes as much as 40%) first go to paying down previously incurred debt. Debt repayment while receiving service is a benefit of prepay that some customers appreciate; however it could also reduce the available income for customers to purchase electricity. Thus a debt repayment requirement could be a factor that influences consumption.

Table 3. Prepay electricity evaluations and findings

Program	Scope of evaluation	Prepay program duration	Electricity savings	Number of prepay participants	Number in control group	Savings control for disconnect	Costs, compared to postpay[14]	Evaluation design	Reference
Eskom, Cape Town, South Africa	Acceptable	~16 months	13%	4,246	No control group	No	Similar	Pre-post, control for selection bias[15]	Jack and Smith (2016)
Salt River Project (SRP) 2008–2009, Arizona	Acceptable	1 year	12%	1,641	1,641	No	Higher	Matched control group, pre-post	Qiu, Xing, and Wang (2016)
Arizona Public Service, Arizona	Acceptable	~1 year	7.50%	86	86	Yes	Higher	Matched control group, pre-post	APS (2015)
Direct Energy, Texas	Acceptable	3 years	9.60%	Unclear	Unclear	Yes	Similar	Non-matched controls, instrumental variable approach	Eryilmaz and Gafford (2018)
Duke Energy, North and South Carolina	Acceptable	2 years	Not statistically significant	74	74	No	Higher	Matched control group, post only	Duke Energy Carolinas (2017)
Glacier Electric	Acceptable	< 1 year	14%	1,240	No control group	Yes*	Not available	No control group, pre-post	DEFG (2014)

[14] For details regarding this variable, see Appendix E.

[15] This evaluation controlled for selection bias by including only participants who were involuntarily switched to a prepay plan. The researchers observed 27 separate groups that switched from postpay to prepay, and randomly determined when each switch would occur.

Program	Scope of evaluation	Prepay program duration	Electricity savings	Number of prepay participants	Number in control group	Savings control for disconnect	Costs, compared to postpay[14]	Evaluation design	Reference
Cooperative, Montana									
Kentucky Association of Electric Cooperatives	Acceptable	~1 year	11.10%	574	No control group	No	Higher	No control group, pre-post	Martin (2014)
Oklahoma Electric Cooperative	Acceptable	~22 months	10.40%	1,217	No control group	Yes*	Higher	No control group, pre-post	Ozog (2013)
Pacific Northwest PenLight, Washington	Limited	~1 year	5.50%	154	No control group	Yes*	Not available	No control group, pre-post	DEFG (2014)
Salt River Project 2003–2006, Arizona	Limited	1 year	12%	463	463	No	Higher	Matched control group, pre-post	EPRI (2010)
TVA 1, Tennessee [16]	Limited	~1 year	5.60%	350	Unclear	No	Unclear	Matched control group, only post	DNV GL (2016)
TVA 2, Tennessee	Limited	~1 year	6.70%	184	Unclear	No	Unclear	Matched control group, only post	DNV GL (2016)
TVA 3, Tennessee	Limited	~1 year	5.00%	201	Unclear	No	Unclear	Matched control group, only post	DNV GL (2016)

[16] Six implementations of prepay by utilities in the Tennessee Valley Authority (TVA) were separately evaluated within one report. The utilities chose to remain anonymous.

Program	Scope of evaluation	Prepay program duration	Electricity savings	Number of prepay participants	Number in control group	Savings control for disconnect	Costs, compared to postpay[14]	Evaluation design	Reference
TVA 4, Tennessee	Limited	~1 year	6.90%	183	Unclear	No	Unclear	Matched control group, only post	DNV GL (2016)
TVA 5, Tennessee	Limited	~1 year	11.70%	145	Unclear	No	Unclear	Matched control group, only post	DNV GL (2016)
TVA 6, Tennessee	Limited	~1 year	6.80%	76	Unclear	No	Unclear	Matched control group, only post	DNV GL (2016)

*The author controlled for the effects of disconnection in the regression analysis but used a procedure that could be debated. See Appendix E for details.

Overall we found 16 individually evaluated programs within 10 reports. Most of the evaluations contained enough information to assess, but eight of these program evaluations were difficult to assess because they provided little information on which we could draw conclusions. Most evaluations had sample sizes below 600 (eight of 16 had fewer than 201 participants) in the prepay intervention group (four had over 1,000), and the duration of data collection from most customers while on prepay was approximately one year (four were longer, one was shorter). Most studies used a pre-post evaluation method or included a matched control group. Therefore many evaluations could be somewhat influenced by a potential self-selection bias and contained somewhat small sample sizes.

The program evaluations listed in Table 3 show that customers who prepay for electricity likely use less electricity than they would otherwise. On average, the estimated energy reductions are approximately 9%, with seven evaluations suggesting reductions under 7% (plus one study that reported only statistically nonsignificant reductions) and five evaluations suggesting reductions of more than 10%. However, the programs cannot be directly compared to one another because they include different elements (e.g., fees, rates, and payment options) and evaluation methods (e.g., control groups and calculation of savings). Many evaluations do not report one or more critical pieces of information (e.g., whether debt repayment is automatically deducted from top-up payments, total costs to consumers, and the size of the control group). Only one evaluation (Kentucky) examined the potential persistence of energy reductions over time, and the author of that report noted that these reductions generally persisted during the program but also diminished over time. This finding concurred with the TVA evaluations, whose authors tentatively concluded that savings were highest for new programs and lower for more mature programs.

We compared customer costs between prepaid and postpaid programs. While it was rare to see a different electricity (kWh) rate between the two payment plans, it was common (in the programs in Table 3) to see additional fees that could make overall prepay costs higher. For some programs, these fees included monthly access charges, third-party vendor fees (such as kiosk or bank fees), or reconnection fees. It was difficult to calculate exact costs to customers because program evaluations did not provide in-depth examination of these details. However, we suspect at least two programs (Texas and South Africa) had negligible differences in costs for customers between prepay and postpay plans.[17]

The South Africa program was one with similar costs (except for some participants who were switched from a lifeline electricity fee when moved to prepay), and it demonstrated an estimated 13% savings. Although the methodology for this program's evaluation was stronger than any other in our review (reducing self-selection bias by only examining involuntary switching to prepay), the context and program type were qualitatively different from those offered in the United States. That evaluation did not exclude savings from customer disconnections, and it was applied in poor regions of South Africa. A Texas prepay program was also likely to have similar costs between prepay and postpay (although exact rates were not disclosed) along with an estimated 9.6% savings. However this evaluation included a nonmatched control group with an unverified number of participants. For the remaining 14 evaluations, six reported likely higher costs (due to fees, transactions costs, and so on) and eight did not provide

[17] See Appendix D for a discussion of costs in each program.

information. Although consumers are not extremely price sensitive, the possible cost difference could help explain some of the reductions in consumption, especially among budget-constrained customers.

Five evaluations excluded savings resulting from customer shutoffs. These programs took place in Arizona APS (7.5% savings), Texas (9.6% savings), Montana (14%), Oklahoma (10.4%), and Washington (5.5%). However, as explained in Appendix E, the procedure used to account for shutoffs in the latter three locations (Montana, Oklahoma, and Washington) may be considered suboptimal by some experts. The other 11 evaluations may have overestimated savings from prepay because they included "energy saved" from disconnections in their savings estimates.

Several factors contribute to our assessment of the quality of evaluations. These include sample size, evaluation time (and, by extension, amount of data used for the evaluation), and evaluation design. In general, a larger sample size and more data lead to more-accurate evaluations as results can apply to the greater population. Most evaluations lasted approximately one year and often included usage data from one year prior to prepay implementation, which is a reasonable length of time and number of data points (assuming monthly billing data were used). Six Tennessee evaluations had short, but borderline reasonable, evaluation periods (approximately one year), and one Montana evaluation had approximately nine months of prepaid usage data, but also some additional (unspecified number of) months prior.

Eight of the 16 evaluations had small sample sizes (201 or less), including five in Tennessee, one in Washington state, one in the Carolinas, and one in Arizona. Small sample sizes can make finding significant results more difficult and make results less generalizable. Savings from all but one of these programs (Carolinas) were statistically significant, but the generalizability of the results to the broad residential customer population from these non–randomly selected (and sometimes small) samples remains a fundamentally unanswered question. This makes it difficult to estimate what the energy usage reduction potential might be from such programs if applied in any broader context.

In terms of methodology, the ideal evaluation would rule out as many extraneous variables as possible to offer the strongest argument that prepay causes reduced energy consumption. As is typical of empirically based energy efficiency evaluations, none of the studies employed a fully random or quasi-random experimental design, which would offer the strongest evidence that prepay causes a change in behavior and energy use. A pre-post evaluation with no control group offers the weakest evidence for causation because it fails to account for possible confounding variables, such as temperature, general economic conditions, and so forth. Four programs used this type of evaluation (with some of the highest savings figures: Montana 14%, Kentucky 11.1%, Oklahoma 10.4%, and Washington 5.5%). A stronger pre-post evaluation includes a matched control group (prepay customers matched to similar non-prepay customers). Seven programs used this type of evaluation, including all those in Tennessee (5.6%, 6.7%, 5.0%, 6.9%, and 11.7% savings) and one from the Carolinas (which was not statistically significant). An even stronger evaluation would combine a pre-post evaluation and a matched control group using a difference-in-difference analysis (examining the difference in usage before and after the time that prepay began and comparing that difference between control and prepay customers). Three evaluations used this strategy, including all three Arizona evaluations (12%, 12%, and 7.5% savings).

The two remaining evaluations used unconventional methods. One of the strengths of the South Africa evaluation is that it ruled out one important potential extraneous variable, self-selection bias, by including only participants who were involuntarily enrolled in prepay. This evaluation used a pre-post evaluation method but observed 27 groups of prepay enrollments that were enrolled on a random schedule, thus strengthening its case for causality. Although the Texas evaluation used a nonmatched control group, evaluators attempted to compensate for self-selection bias statistically. Even so, the method of implementing this compensation could be argued to be not as effective as the inclusion of a control group (see Appendix E for details).

Some of the reported energy reductions could have been the result of deprivation as opposed to energy efficiency behaviors. Only one of the evaluations that we reviewed measured the energy-reduction actions of prepay customers (Oklahoma). This report found that customers self-reported numerous specific behaviors, such as turning off lights, lowering water heater temperatures, and changing appliance usage. Of the reported behaviors, two correlated with actual usage reductions: (1) purchasing a new thermostat and (2) allowing electricity to be remotely disconnected (which could be associated with deprivation). In New Zealand and Mozambique, in-depth interviews with prepay customers complemented these findings (O'Sullivan, Viggers, and Howden-Chapman 2014; Baptista 2015). Increased feedback while on prepay plans facilitated learning about electricity use from different appliances and subsequent rationing of their usage. However the New Zealand study also noted that prepay plans "encouraged householders experiencing severe hardship to take extreme measures when restricting their energy use" (O'Sullivan, Viggers, and Howden-Chapman 2014, p. 1).[18] The question of deprivation, therefore, remains unanswered, and we examine it in more detail later in this report.

The generalizability of these results to a broad Minnesota residential customer population could be problematic. Prepay plan evaluations that reported participant information had customers that were not representative of the general population, and sometimes a small numbers of participants.[19] This could make estimation of savings in a broader context difficult.

Overall, the 16 evaluations demonstrate that customers on prepaid electricity programs on average reduce their consumption relative both to their previous usage on postpay and to other customers who stayed in postpaid programs. However, current evaluations make the degree of expected savings difficult to quantify. To date, few studies offer high-quality evaluations that have large sample sizes and long durations, exclude energy reductions from disconnections or deprivation, and effectively control for self-selection bias.

Several explanations exist as to why prepay programs reduce consumption, and some of these are not unique to prepay. In the following sections of this report, we delve further into these questions and explain why each element or possible cause of savings needs to be examined independently (with additional details provided in Appendix B).

[18] For example, extreme measures may include self-disconnection while residents are at home.

[19] In many cases, prepay participants have low incomes or have difficulties with payment under postpay billing plans.

Prepay Elements That May Cause Energy Reduction

As outlined in the previous section, most current evaluations do not examine which prepay program elements cause electricity use reductions. Pilot designs that isolate the effects of each program element can determine the exact influence each element has on behavior change and electricity consumption. Isolating prepay and postpay differences is important because some elements are criticized for causing deprivation among vulnerable populations, some can be added to postpay programs, and some are unique to prepay. If the effects of these elements are known, program designers can customize programs to effectively save energy while avoiding negative impacts on participants. Evaluations that isolate elements would also determine whether specific elements of prepay could save energy on their own or must be couched within a complete prepay program. We examine these issues because the goal of this report is to investigate energy savings potential of prepay as opposed to general acceptability.

Given the lack of experimental evidence or high-quality quasi-experimental research, we are left with hypotheses about key program elements that, based on previous research, could explain the reduction in consumption attributed to prepaid programs. Some of these elements could be added to postpaid programs, and some are best introduced only as parts of a prepaid program. In Table 4, we review six key elements that differ between prepaid and postpaid programs that can reduce energy consumption on their own, as demonstrated by behavioral science research. Each of the following program characteristics may contribute in varying degrees to prepaid electricity program estimated savings. Only one of these elements is unique to prepay—paying in advance. Active payment, inconveniences, costs to customers, and quick disconnections may be added as elements in postpay programs, though they may be more difficult to include. Postpay programs can easily incorporate feedback elements, especially in areas where smart meters are installed. In Appendix B, we explain how and why these elements work to save energy independent of prepaid programs.

Table 4. Prepaid electricity plan elements that may cause energy reduction

Element	Explanation
Feedback	Prepay plans come with real-time (or near-real-time) feedback about remaining credits and/or energy use. The feedback is described in metrics the customer can understand and facilitates learning and empowerment to make changes to behavior. This feedback helps customers understand how behavior, electricity use, and cost are linked. People who receive feedback about electricity use generally reduce their consumption. Although this effect may be increased when it is provided in the context of prepay, feedback also exists independently of prepaid plans. Notably, this element can be implemented in postpay.
Fast shutoff	Customers (particularly those with constraints on income) may defer action on electricity bills until there is an immediate risk to health, safety, or well-being. By making disconnection immediate, customers are more likely to act quickly to keep their power on, even if they are struggling to pay for other necessities. In addition, the savings from some programs can be partly accounted for by service disconnections, as opposed to energy efficiency behavior change. Implementing faster and stricter disconnection policies would be difficult for postpay plans, as customers pay after receiving service.

Element	Explanation
Costs to customers	Some evaluated prepay plans are slightly more expensive for customers than equivalent postpay plans. This slight difference in costs may explain a small part of the difference in consumption. Some of the evaluated programs include built-in debt repayment measures, so part of a top-up payment goes to arrearage reductions. Although this may be a benefit for customers, it nevertheless leaves them with less money to spend on electricity. At least one program we are aware of had a large number of customers in this situation (EPRI 2010). In many cases, top-up payments also have transactions fees. Therefore the overall program costs may be higher for all customers, which impacts income-constrained consumers. These higher costs can partly explain electricity savings. Using this method—increasing costs to reduce electricity consumption in postpay plans—is not recommended, especially for programs that typically target low-income customers.
Usually more frequent payments	In currently available program evaluations, consumers on prepaid plans usually pay for electricity more frequently than those on postpay plans. Paying more frequently could increase the chances of missing a payment or, especially for customers traveling to a kiosk, increase the overall effort required to pay for electricity. This overall effort could act as a slight barrier to topping up and could, therefore, on average across all participants, slightly reduce electricity consumption. Conversely, postpay customers usually pay only once per month, at a time that is convenient (within the span of several weeks after receiving the bill), or they can subscribe to autopay, which automatically pays their bills each month, further decreasing effort. Consumers in an SRP evaluation traveled an average of two to three miles to a kiosk to purchase electricity credits three to four times per month. This potential behavior-influencing factor cannot be easily applied to postpay.
Active payment	Individuals who are made to actively decide how much credit to add to their electricity account may subsequently pay more attention to the electricity they are using. Prepay customers typically purchase credits more frequently than postpay customers pay their bills. Each time prepay customers reload, they must choose how much to add. This increased attention and decision making may subsequently lead participants to pay more attention to how much electricity they are using. One Texas prepay program sent customers energy bills each day. It would be challenging for utilities to use this strategy of active payment methods with postpay customers, and if prepay implementers create an autopay option then this factor may become less important and behavior change might be slightly reduced.
Paying in advance	All else being equal, people spend more money when using credit cards than when using cash. Loading up prepay meters in advance of using the electricity is like the process of getting cash from the bank before spending it. Conversely, paying for electricity after using it is like spending credit and then paying the balance later. Possibly the same mechanism that works to reduce spending with cash also works to reduce spending on electricity for prepaid program participants. This is likely a limited effect and one that requires additional research. Although postpay customers can pay in advance, the requirement to do so is unique to prepay, and therefore few postpay customers take up that option. Utilities are unlikely to save much electricity by using this strategy within a postpay context.

Feedback

Although an in-depth discussion of most of these behavioral influences can be found in Appendix D, we elaborate here on one specific factor, feedback. One universal aspect of prepaid electricity programs is the inclusion of some sort of feedback mechanism that allows consumers to learn how much energy they are consuming. In some cases, this may be in-home displays that provide real-time information

(Faruqui, Sergici, and Sharif 2010), and in others it might be text, email, or phone alerts when customers' balances are low (Martin 2014). Modern programs that use smart meter technology also have the option of providing feedback on the web, in mobile phone apps, or through other integrated devices. As recommended by psychology researchers, new prepay software companies present their feedback in metrics that matter to consumers (e.g., dollars rather than kilowatt hours), and they use messages that are motivational and empowering. Prepay customers, even without smart meters, have reported using this feedback to systematically test appliances in their homes to learn how much electricity each one uses (O'Sullivan, Viggers, and Howden-Chapman 2014). International examples of prepay programs rarely use smart meters and instead usually provide feedback through a wall-mounted in-home device (often called a *keypad*) that is used to control the home's electricity and facilitate recharging of the account (see Esteves et al. 2016 for photos of some common devices). Nevertheless feedback is important in all contexts.

Feedback is a behavior change strategy that is supported with a large body of evidence from the field of psychology and can reduce energy consumption on its own, without the need to pay in advance (e.g., Karlin, Zinger, and Ford 2015). However feedback within the context of prepay may be more powerful than within postpay. Aside from using effective messaging and metrics that empower customers, they also come bundled with other motivators that encourage customers to attend to the feedback. One Japanese study found that the amount of attention participants paid to their feedback (i.e., the frequency of use of their in-home displays) affected their demand elasticity for energy (Matsukawa 2004). This suggests that participants who are motivated to pay attention to their feedback devices might be more likely to conserve electricity. If other aspects of prepay programs (e.g., rapid shutoff) can motivate this increased attention, then feedback might have a stronger impact on behavior. This hypothesis has yet to be directly tested, but it could explain why feedback alone might not reduce electricity usage as much as within a prepay context.

Another difference between prepay and postpay feedback is the presentation of loss as opposed to gain. Feedback in prepay programs usually takes the form of information about the amount of electricity that consumers have remaining in their accounts, as opposed to the amount of electricity that they have spent so far (i.e., consumed from a specific point in time). This counting down in prepay as opposed to counting up in most feedback research could somewhat invalidate a comparison between the feedback research to date and prepay feedback. Although some nonexperimental evidence indicates that in-home display programs with prepay might, in some cases, encourage consumers to use less electricity than programs that use only in-home displays without prepay (Faruqui, Sergici, and Sharif 2010), this evidence is equivocal and no program has yet tested the effects of a counting-down feedback approach without prepay. Feedback that is presented as a countdown might be innately more effective than feedback that counts up because of a loss aversion effect (Tversky and Kahneman 1991).[20] Therefore future studies comparing the effectiveness of feedback in conjunction with prepay and postpay plans should use the same (countdown) type of information with both types of plan to get an accurate understanding of the potential additive effects of prepay.

[20] *Loss aversion* refers to the general tendency for people to prefer avoiding losses to acquiring equivalent gains.

Effective feedback (with messages that motivate and empower customers) may be a primary reason that prepay plans reduce electricity consumption, and this is not a feature that must be unique to prepay. However, more research is needed to learn whether feedback is more powerful within the context of prepay than with postpay. Tests are needed that explore feedback devices with and without prepay and with information that is presented in an equivalent manner.

Uncertainty about the Most Important Influences

Without experimental trials to test prepaid electricity program elements independently and together as one program, we cannot say with certainty which elements are required for prepaid programs to change behavior and reduce electricity consumption. The full suite of influences working together may be required to change behavior. However, if savings can be achieved without fast shutoffs or increased costs, implementers may wish to create prepay programs that exclude these factors. If energy efficiency is the goal of the program, then examining these influences independently is important.

Some evidence from qualitative interviews with prepay participants indicates that the combination of prepay program factors, especially feedback and disconnection, work together to reduce consumption (e.g., O'Sullivan, Viggers, and Howden-Chapman 2014). Prepay program customers learn from the feedback they receive and are motivated to pay attention to that feedback to avoid using up their credit and getting electricity shut off. They are also more motivated to understand how much behavior affects electricity usage because they are more engaged in paying electric bills. Customers do not claim that the increased costs associated with prepaid electricity programs affect their behavior, but as with any qualitative interview-based study, answers that are explicitly provided may not explain all behavior variances. This may require additional examination.

Could these behavioral influence elements be incorporated into postpay plans to achieve the same conservation effects? For some aspects, the answer may be yes. Postpay plans could include enhanced feedback devices that provide understandable and motivating information to customers (more than provided by traditional feedback devices). If most of the prepay conservation effect is the result of this type of feedback, then the result could be replicated with postpay customers as well. Further research would be needed to determine whether clear feedback on a declining available account balance has more impact on consumption than feedback on how much energy has been used. For example, customers could be alerted to a pattern in their usage and predicted bill amount, e.g. "You have $x of electricity usage left this month before you reach your average for this time of year."

Other elements are more difficult to apply. Postpay plans could have stricter (and faster) disconnection policies, they could encourage customers to pay small amounts more often or in advance, they could be made more expensive, and they could require active payment (rather than allowing autopay). However, these policies would likely be unwelcomed by regulators, consumers, and utilities alike. Prepay programs could likewise have less-strict disconnection policies (or no disconnections, which some have proposed), could have identical costs (which some do), and could allow autopay (which some do). Even so, this full combination of user-friendly practices has yet to be tested for electricity savings. Prepay

programs with and without these elements would need to be systematically tested to understand which elements are most important to achieve energy savings.

Prepay Considerations from Opponents and Advocates

The case for prepaid electricity as an energy efficiency program has both strong proponents and opponents from across a variety of sectors. Through our interviews and additional research, we identified a variety of considerations raised by both sides. As Minnesota stakeholders contemplate prepay programs as a potential part of the state's energy efficiency strategy, they should examine these considerations. We begin with an examination of why prepay programs are usually implemented and then move to a discussion of themes that are raised by opponents and advocates of prepaid electricity.

Motivations for Implementing Prepaid Electricity Programs

Most utilities implement prepay programs for reasons other than energy savings. In many cases, evidence points to the expansion of prepaid electricity options internationally (Esteves et al. 2016) and domestically (Prepaid Energy Hub 2015) without an energy efficiency focus. In countries such as Australia, New Zealand, and the United Kingdom (and especially Northern Ireland), utility companies implement prepay options to reduce debt collection issues and nontechnical electricity losses (primarily caused by fraud activities), as well as to help low-income households avoid high bills (Esteves et al. 2016).

Although US prepay programs are less established, DEFG has collected information on the initial US programs. In their database of 40 programs (N. Treadway, Managing Partner, pers. Comm., July 12, 2018), implementers claim their primary reasons for implementation are[21]

- Providing customers an additional payment option (18 programs)
- Reducing debt, offering debt recovery options while keeping electricity on, reducing write-offs (8 programs)
- Providing energy efficiency, demand-side management (DSM), or conservation programs (8 programs)
- Increasing customer satisfaction or customer service (7 programs)
- Avoiding deposit required for postpay (7 programs)
- Leveraging installed AMI technology (3 programs)

The potential costs and benefits of prepaid electricity plans include both direct and indirect considerations. In Table 5 and Table 6 we summarize these costs and benefits, based on our stakeholder interviews and literature review (in particular DEFG 2016).

[21] Some programs have multiple reasons.

Table 5. Prepay program costs and benefits to customers

Potential costs	Potential benefits
Potential additional monetary costs for[22] - Higher kWh rates - Program fees - Security deposit (for in-home display) - Reconnection or disconnection fees - Transaction fees from third-party vendors, such as payment kiosks - Communication costs (e.g., text messaging) Required payment of - Outstanding debts with every top-up (up to 40% of top-up payment can sometimes be required to go toward arrearages) - Minimum amount for top-up purchases Time spent - Paying for electricity (typically several times per month) - Commuting to a location more frequently to pay for electricity, especially if paying by cash or check[23] - Learning about household behavior and electricity use Potential health or safety effects from going without electricity more frequently[24]	Reduced electricity usage Increased knowledge about how behavior relates to electricity use and electricity costs Increased sense of control from - Electricity budget being set in advance - Allowing more convenient payment options than postpay - Having a larger selection of electricity plans from which to choose - Allowing small incremental payments, when cash becomes available Allow budget-constrained customers to continue getting power by - Providing an option that does not require an initial deposit - Providing a way for customers to pay off arrearages over time while still receiving electricity service

[22] Many new programs waive these additional fees.

[23] An estimated 11% of Americans pay electricity bills in person (Albertazzi 2017).

[24] Prepay customers may go without electricity more frequently, but some evidence suggests that disconnection periods may be shorter than in postpay (APS 2015). The difference in health effects from disconnections under both plans requires additional research.

Table 6. Prepay program costs and benefits to utilities

Potential costs	Potential benefits
Investment in - Advanced metering infrastructure - Communications - Meter data management - Customer information system - Systems build/integration - Call center (staffing, training) - Prepay software Payment for - Transaction fees (if third-party charges are covered by the utility) - Legal - Marketing Effort and time for - Business change - Regulatory approvals Reputational effects from - Perception that utility is motivated by revenue recovery - Consumer advocate criticism - Negative media attention	Increased revenue from - Better revenue recovery - Sometimes higher rates - Avoided costs for paper billing - Avoided collections and termination costs - Fewer nontechnical losses (usually fraud activities and theft) Improved customer satisfaction from - Reduced customer abandonment - Improved customer experience - Providing additional plan options Improved business practice outcomes from - Possible higher call center morale because customers may call less frequently about high bills and shutoff complaints - Utility meeting its mandate to leverage advanced metering infrastructure technology

Table 7 provides a brief overview of each prepay consideration or theme we identified through interviews and research. Appendix A contains more detailed information about each interview theme.

Table 7. Common themes from interviews about prepaid electricity plans

Category	Theme	Description
Research	Lack of research	Current research does not adequately explain why prepay energy leads to energy savings. More and better studies should be conducted to provide better program evaluations.
Customer	Customer satisfaction	Many prepay programs highlight high customer satisfaction.
	Customer control	Prepay allows customers to control their energy use and save on their energy bills.
	Voluntary	Prepay should be a voluntary opt-in program.
Utility	Utility costs	If prepay is not counted as an energy efficiency program and customers do see an energy reduction, utilities may face lost revenues.
	Utility savings	Utilities can recoup customer payments that may have been lost in arrearages through payment options in a prepaid plan.
	Prepay instead of other efficiency measures	Some advocates argue that utilities should spend their money on typical energy efficiency programs, and using prepay plans as energy efficiency programs could be a distraction or divert resources.

Category	Theme	Description
Consumer protections	Disconnection as main motivation for energy savings	While disconnection is a contentious issue for consumer advocates, disconnection likely is a strong motivator of energy savings.
	Deprivation	Some are concerned about whether prepay motivates customers to save energy through efficiency actions or deprivation actions.
	Quality-of-life concerns	Some believe that prepay will improve quality of life, while others are concerned that it will reduce quality of life.
	Targeting low-income customers	Many prepay programs tend to target low-income customers either overtly or indirectly. Given the vulnerability of this group, consumer protection concerns are particularly important.
	Equity concerns	Concerns center on ensuring that prepay programs maintain consumer protections.
Regulation	Regulatory concerns	Some regulatory decisions have rejected prepay programs for several reasons.

Research-Related Themes

Prepay electricity program evaluations do demonstrate energy savings. However most interviewed stakeholders—including both prepay advocates and consumer advocates—indicated that more research is needed to determine whether prepay should become a utility efficiency program offering. Researchers suggested that evaluations should parse out different elements of prepaid programs to determine what leads to energy savings. Pilots could also see what impact disconnection has on energy savings by testing financial motivators such as late-pay penalties or rewards for on-time payments. Interviewees also suggested collecting information on self-disconnection statistics to better track and calculate prepay electricity savings. In addition, one consumer advocate felt so strongly against prepay programs as an energy efficiency measure as to believe it was unethical to even study prepay as a pilot program. Even so, with proper oversight, consumer protections, and strong evaluation design, prepay pilot programs can provide important information to help regulators determine whether prepay is an ethical approach to energy efficiency.

Customer-Related Themes

Customer Satisfaction

Existing program evaluations suggest that prepay program customers feel a high sense of satisfaction. In some cases they may prefer prepay to postpaid plans despite some of the potentially punitive characteristics (e.g., Baptista 2015; O'Sullivan et al. 2013). Our interviews with one prepaid program proponent cite anecdotal evidence of customers calling utilities to thank them for the program. An academic expert who had interviewed low-income customers also mentioned that some Arizona interviewees specifically chose to live in regions that had a prepay program. Some consumer advocates

claim that satisfaction surveys from utilities and prepay advocates are not made public, and therefore questions asked cannot be scrutinized. However, we found that these surveys do tend to align with peer-reviewed research and our interviews with nonaffiliated parties. Minnesota utilities also found the customer satisfaction research to be very compelling and worth closer examination. These utilities felt that prepay payment options provided customers and members with a convenient and transparent way to handle utility bills.

Customer Control

Stakeholders often cited customer control as a prepay program benefit because customers can reduce the surprise of a high bill by setting their energy budget and paying in advance. They can also understand how behavioral choices and actions affect their utility bill on a near real-time basis versus waiting a month to see their use over a long period. One Minnesota utility felt that because customers will not be surprised by big bills—one of the main reasons customers call—prepay programs can be a carrot rather than a stick. For customers without much financial flexibility, having transparent and real-time data will allow for better bill management. Although this was a clear theme in discussions with stakeholders, we note that at least one report suggested that customer control may not necessarily be a characteristic that must be unique to prepay (Howat and McLaughlin 2012).

Voluntary Program

Most, if not all, stakeholders indicated that prepay programs should be voluntary opt-in programs. The majority of US prepay programs are voluntary in that they allow customers to switch to other payment methods if they are unhappy. While many stated that prepay programs are currently opt-in, some consumer advocates argued that prepay is not always voluntary due to barriers, such as high deposits or accumulated arrearages, that may prevent a customer from enrolling in another payment plan.

Utility-Related Themes

Utility Costs

Although customers enrolled in a prepaid program may have potential energy savings, some utilities have regulatory concerns that prepay programs cannot be counted toward efficiency. Regulatory-sanctioned energy efficiency programs allow a utility to count savings toward their efficiency portfolio. However, if programs are not considered efficiency, savings may lead to reduced revenue over time. One consumer advocate suggested that prepay programs could be added to utility decoupling models separately from energy efficiency so that costs can be recovered from reduced revenue without counting prepay toward utility efficiency requirements.

In addition, utilities incur associated prepay program infrastructure costs, such as the installation of AMI. While many utilities are moving toward AMI, Minnesota has been slow to increase penetrations across

the state, with smart meters accounting for less than 20% of all residential meters (EIA 2017). Although programs in other regions of the world have operated prepay programs for decades without AMI, these meters are the North American standard for their ability to provide granular data on real-time energy use through in-home displays and smart devices. One Minnesota utility said they would not want to move forward with prepaid programs without AMI because real-time data impact customers the most. AMI also allows utilities to communicate via multiple channels.

Utility Savings

Prepay programs often address arrearage repayment issues by incorporating debt repayment into each bill top-up payment. This payment option may be more manageable for customers in debt, potentially allowing them to stay out of future arrears. Utility stakeholders and other prepay proponents have suggested that this process helps both the customer and the utility in terms of reducing overall arrearages and, in turn, decreases associated accumulated debt costs for the utility.

Interviewees cited additional utility cost savings associated with disconnections. AMI with a prepay program structure allows for these savings as the utility can disconnect customers remotely and reconnect them quickly—often within hours and with no need to send a technician to the home. Opponents argue that this benefit may not be unique to prepay but rather to AMI implementation.

Prepay instead of Other Efficiency Measures

As noted earlier, whether prepay programs should be considered for energy efficiency program portfolios is subject to debate. Current evaluations suggest that prepay programs can gain significant energy savings. However, several consumer advocates voiced concerns that these savings accrue at the cost of consumer comfort or basic needs. Some felt that the savings were primarily from deprivation and disconnects. One advocate felt that while prepay did allow customers increased control over energy bills, more research is needed to determine the effectiveness of prepay as an efficiency measure. Many consumer advocates felt that utilities should spend money and resources on traditional energy efficiency program measures, such as retrofits and weatherization, rather than on prepay infrastructure.

Utilities, especially those in Minnesota, expressed strong interest in having prepay as both a payment option and a behavioral efficiency program, like home energy reports. They felt that having prepay included as an energy efficiency program would allow them to offer a service that customers want, save energy, and recuperate costs. This becomes especially important as the market transforms for other efficiency measures.

While this topic is still debatable, it is important that it be resolved. In our recommendation sections, we provide a path to building consensus on this issue in Minnesota.

Consumer Protection–Related Themes

Automatic Shutoff

While likely a significant contributor for high energy savings from prepay programs, disconnection is also the most contested prepay program design element. Prepay program advocates highlight the ease with which customers can be disconnected and reconnected without additional fees. Consumer advocates tend to oppose the automatic shutoff element of prepay programs and voice concerns around proper disconnection notification, energy assistance program access, and potential for shutoffs without adequate warning or emergency assistance. One consumer advocate said that disconnection was the core issue, stating that customers can receive feedback and other prepay program benefits without automatic shutoffs—which can lead to higher personal and societal costs such as food and medication loss from refrigerator thawing. Another consumer advocate indicated being less concerned about automatic shutoffs if customers received adequate warning, such as through an in-home display or a live phone application. In addition, most new prepay programs exclude customers who require electricity for medical reasons to avoid life-threatening impacts from disconnection.

Some Midwest stakeholders indicated they were concerned about the automatic shutoff aspect of prepay programs and were interested in exploring ways to avoid disconnection. Some evidence suggests that prepay customers may experience more-frequent disconnections than those on postpay, but two American evaluations found the average amount of time on prepay without electricity is usually about seven hours or less (DEFG 2014; APS 2015).[25] Conversely, a peer-reviewed New Zealand study on prepay found that one-third of respondents self-reported disconnections lasting over 12 hours in the past year (O'Sullivan et al. 2013). In general, while some disconnections result from budget constraints, most customers claim they occur due to forgetfulness or lack of time (Mummery and Reilly 2010; O'Sullivan, Viggers, and Howden-Chapman 2014). However one interviewee pointed out that embarrassed customers may understate the frequency of shutoffs due to budget constraints.

We spoke with two Minnesota utilities that were reluctant to include remote disconnects as part of the program yet would seek regulatory guidance on the appropriate path forward. One method by which a program could be implemented without remote disconnects is providing the customer a short grace period, followed by a transfer to a traditional postpay structure.[26] For Minnesota, a particular issue will be avoiding or minimizing disconnections during the prime heating season.

[25] Based on a limited comparison of 16 people, one evaluation found that the duration of disconnection was significantly shorter on prepay than on postpay (APS 2015).

[26] One example of this procedure was proposed by a Midwest utility for a new prepay pilot program (that has since been withdrawn). Under the proposed program, low-income consumers who reach a $0 balance could accrue arrears for eight days before being transitioned to a postpay plan. Any arrears accrued before being transferred would be paid back by garnishing prepay customers' top-up payments by 25%. The prepay plan would not require a deposit for initiating service.

Deprivation or Energy Efficiency Behavior

Minnesota lawmakers define *energy efficiency* as a reduction of energy consumption "without a reduction in the quality or level of service provided to the energy consumer."[27] Therefore a program that reduces quality of life or causes consumer deprivation would not be considered effective energy efficiency. Quality of life is primarily a subjective concept, but it also has some objective components (see Glossary for further details). Examining prepay plan effects on participants' specific behaviors and perceptions may help shed light on whether prepaid electricity plans reduce or enhance quality of life and therefore should (or should not) be considered energy efficiency. In this section, we combine our interview data with information from available literature to evaluate whether prepay plans may negatively or positively influence quality of life.

Improving Quality of Life

Most peer-reviewed academic research on international prepay examples (e.g., Baptista 2015; Mioyogo, Nyanamba, and Nyangweso 2013; O'Sullivan, Viggers, and Howden-Champan 2014; O'Sullivan et al. 2013), along with most other domestic and international prepay reports (e.g., CER 2011; Z2Solutions 2014; DOE 2015; Wimberly 2014), agree that customers on prepaid electricity plans are satisfied with the service and may, therefore, experience a slight improvement in their subjective quality of life. O'Sullivan and colleagues (2013, 2014) interviewed and surveyed prepay customers to understand what they think of the program and how it has changed their behavior. She found that, despite a few concerns, such as the physical location of the meter in their homes and the accessibility of payment kiosks, consumers liked the program. Her participants were in New Zealand and, despite higher per-kWh rates for prepay (at the time) and higher likelihood of disconnection, they nevertheless felt that the benefits of prepaid electricity outweighed the costs. Interviews by Professor Diana Hernandez at Columbia University of prepay program participants in Arizona found that they generally favored having prepay meters, as it allowed them to "closely monitor consumption, manage costs, and avoid large bills." Some participants mentioned choosing where they lived based partially on the availability of prepay (D. Hernandez, professor, Columbia University, pers. comm., July 12, 2018).

Similarly, program evaluations such as those in rural US cooperatives report customer satisfaction rates of 80% or higher (Z2Solutions 2014; DOE 2015). Consumers like prepay programs because they help participants budget and control their bills (e.g., Wimberly 2014), avoid large deposits required for postpay plans (Z2Solutions 2014), and provide flexibility for controlling use (e.g., topping up with frequent small payments when cash is available; D. Hernandez, Columbia University, pers. comm., July 12, 2018).

Prepay customers also learn about how much electricity each household behavior uses in ways that most postpay customers do not. Those with limited incomes can then ration and budget electricity use for what is most important to them (O'Sullivan, Viggers, and Howden-Chapman 2014; Baptista 2015). For example, consumers may cut back on ironing their clothes because they learn how much electricity

[27] Office of the Revisor of Statutes, 2017 Minnesota Statues, section 216B.241, subdivision 1 is available online.

that small task can use (Baptista 2015). They may also prioritize a variety of activities that add to a rich quality of life. Limited-income individuals who must choose between necessities appreciate the flexibility of prepaid electricity plans. Prepay electricity will not alleviate poverty issues or reduce energy burdens, but it allows these customers to control electricity usage without going into debt. For those with debt, prepay allows customers to pay down the balance while keeping the lights on.

According to the few surveys and available interviews, prepay program participants are satisfied with the program and do not indicate they feel deprived of energy use. Notably, however, some surveys are conducted by proponents of prepaid electricity (e.g., Wimberly 2014, 2018), and none include participants who chose to switch from prepay back to postpay. Therefore, although the overall evidence suggests that customers like prepay plans, this finding could be somewhat influenced by a selection bias.

Reducing Quality of Life

Despite evidence that points toward improved subjective well-being, consumer advocates argue that prepay electricity plans reduce quality of life for three primary reasons:

- They increase the number of disconnections.
- They may reduce customer protections.
- They can be more expensive.

In response, most modern proposed or planned prepay electricity plans attempt to address these concerns. Nevertheless several recent state regulatory decisions have gone against applications for prepaid programs and pilots because of consumer protection issues (see Appendix C for a review of these decisions).

Subjective well-being and objective well-being may not always align. Although subjective well-being and satisfaction are important to consider, objective measures of fairness and health are also worth examining. For example, consumers may be willing to spend more to participate in a prepaid electricity program and may experience increased subjective well-being, but from a macro perspective those additional costs may nonetheless reduce quality of life (especially given that prepay consumers usually have lower incomes), and more objective health measures might be useful to examine. Prepaid electricity plans may be appreciated by plan members, but advocates argue that other programs may reduce electricity use while better protecting low-income customers.

Few studies investigate the health outcomes of low-income prepaid electricity plan customers. Professor Diana Hernandez recently interviewed several low-income residents in Phoenix, most of whom were using prepaid electricity plans, and found that while the prepay participants she interviewed liked the program on a widespread basis, they also described depression, anxiety, and worry over their inability to pay bills as well as physical health conditions that emerged due to this stress (D. Hernandez, professor, Columbia University, pers. comm., July 12, 2018). One New Zealand study found that prepaid electricity customers sometimes reported cold housing, with 57.2% claiming they could see their breath condensing inside at some point and 67.5% stating that they were shivering on at least one occasion

(O'Sullivan et al. 2013). Nevertheless more studies of objective health outcomes of prepaid electricity customers are needed.

In New Zealand in 2011, elderly and those with chronic obstructive pulmonary disease (COPD) on prepay plans reported in interviews that they were concerned they might be left without power for required medical devices (O'Sullivan, Howden-Chapman, and Fougere 2011). Responding to concerns that low-income prepay consumers may engage in extreme self-rationing that can prove a health and safety risk, most prepay plans now include consumer protection clauses and do not allow customers with certain medical histories to participate. Traditional postpay plans include consumer protections that require sufficient notice before disconnection.

According to research conducted in New Zealand, prepaid electricity programs may not be an effective method of alleviating fuel poverty for the poorest customers (O'Sullivan, Viggens, and Howden-Chapman 2014).[28] Although low-income customers may feel empowered by prepay, they simultaneously put themselves at risk from disconnection-related problems. These customers are most likely to ration their electricity use but have fewer rationing options than others and less money to invest in energy upgrades. Therefore they are more likely to self-disconnect and experience other negative health and quality-of-life impacts (O'Sullivan, Viggens, and Howden-Chapman 2014). Notably, disconnection can also be a problem for some customers in postpay plans.

According to the current Minnesota application for the federal Low-Income Home Energy Assistance Program (LIHEAP), low-income prepay customers would likely qualify for the seasonal benefit, but the crisis benefits might need to be revisited in the context of prepay (because one of the criteria is that electricity is about to be shut off, which may happen more frequently under a prepay plan).[29] LIHEAP seasonal benefits are provided to families based on energy cost, household size, and income (MN Department of Commerce 2018). However, LIHEAP applications are not consistent across states, and some agencies may find it difficult to provide prepay customers with bill assistance subsidies through LIHEAP or other bill payment programs. Some states require high bills or arrearages to award a LIHEAP grant, which is not possible on a prepaid plan (LIHEAP Clearing House 2014). Prepay customers in those states who benefited from LIHEAP may, therefore, experience a reduced quality of life. Notably, even if LIHEAP crisis funds are made available to prepay customers, they may not arrive quickly enough to avoid shutoff (Utility Bill Assistance 2018).

Targeting Low-Income Customers

Low-income customer impacts are important to consider. Some consumer advocates are concerned about how prepay and automatic shutoffs affect customers already strapped for resources and susceptible to disconnections. Some propose denying these customers access to prepaid programs, while others advocate state-level customer protections for enrollees. As an example, programs can

[28] *Fuel poverty* is defined by Hills (2012) as a state in which a household's required fuel costs are above the median level, and after paying the energy bill the household is below the official poverty line.

[29] The application is available online at the Minnesota government website.

ensure that prepay customers receive adequate notice and have access to bill payment assistance programs or receive discounted kWh rates.

While most prepay programs do not indicate that they are directly targeting low-income customers, many are either indirectly enrolling or attracting them. According to our literature review and interviews, part of the reason that low-income customers are drawn to prepaid electricity program participation is that they prefer not to pay or are unable to pay the deposit required for postpaid plans. In other cases, these customers have arrearages that must be settled before they can re-enroll in postpaid plans (Howat and McLaughlin 2012). Low-income customers with constrained budgets sometimes like the predictability and control they get from prepaid electricity plans (e.g., Wimberly 2014). Budget-constrained consumers may also reduce their consumption more than any other income group in response to enrolling in prepaid electricity plans (APS 2015; Jack and Smith 2016).

Equity Concerns and Consumer Protections

Interviewees stressed that prepay programs may pose some equity concerns in terms of program design and implementation. Some program design costs, such as topping-up transaction fees or text messaging fees, are borne by the customer. Utilities sometimes charge prepay program customers a higher rate as well. These factors may make the program more expensive than other payment options, which is particularly concerning for low-income program participants.

Regulatory Concerns

State regulatory decisions regarding prepay programs are few. This is largely because electric co-ops, not typically subject to state rate regulation, implement most prepay programs. State regulators are usually bound by extensive consumer protection rules and have expressed concerns about consumer protections when faced with prepay program proposals from state commission–regulated investor owned utilities (IOU). Regulators also find it more difficult to approve waivers of shutoff rules and are often challenged by consumer advocate groups during IOU prepay proposal proceedings.

We reviewed seven recent state regulatory decisions pertaining to the following utilities: Arizona Public Service (2015), PECO (PA PUC 2018), Duke Energy Ohio (OH PUC 2010), Progress Energy Carolinas (NCUC 2012, 2018), Ameren Missouri (MO PSC 2017), Westar (KA CURB 2016), and SDG&E (CA PUC 2014). We briefly summarize each of these decisions in Appendix C. These utility applications for prepaid electricity pilots or program expansions were denied for several reasons. The most common was a concern that the proposed programs would not provide sufficient consumer benefits and, in some cases, might cause consumer deprivation. Another common reason for denial was an insufficient argument for the programs' cost effectiveness as a customer billing option. Energy efficiency was rarely positioned in these proceedings as a key benefit of prepaid electricity programs.

Minnesota Regulation

The long heating season in Minnesota is also an important factor in regulatory reviews of prepay programs. Under postpay plans, customers' unpaid use of electricity during especially cold months is accumulated as arrears. Under a prepaid system, customers who run out of electricity credits generally cannot accumulate arrears. In some regions, such as Northern Ireland, this problem is addressed by the provision of small amounts of emergency credits that can be used by customers whenever they like and then paid back through garnishing of top-up payments. This may not work in a region that could have extended peak cold events. Minnesota regulators should specifically address the issue of cold-weather shut-offs in any future discussion of prepay.

A Note on Prepay Programs for Natural Gas Utilities

While our study is focused on prepaid electric programs, a few are offered in natural gas service territories. During our stakeholder interviews, we spoke with a Minnesota natural gas utility to understand their perspective on the feasibility of prepay programs in their service territory. While natural gas and electrical prepay programs have some similar issues, natural gas consumption is fundamentally different from electricity consumption. Consumer protection issues during disconnects are especially important for natural gas utilities due to Minnesota's cold weather rule, but a safety issue also needs to be addressed. If gas is shut off, pilot lights would also go out. For a home without electronic ignition, each pilot would have to be relit manually. If they were not relit, they would pose a serious safety hazard.

An additional issue is around the AMI installations. The natural gas utility representatives that we spoke to did not expect any future AMI installations, and any potential program savings would not justify expensive new meter installation costs.

Potential Energy Efficiency Impacts of Prepay in Minnesota

Estimating Impacts

Given the limitations regarding the available evaluations on this subject, estimating the potential impacts if Minnesota utilities were to offer customers prepayment options is difficult. We are unaware of any other state that has attempted to calculate such an estimate. In producing the estimates contained herein, we made several assumptions on both prepay program structure and technical infrastructure required for a robust program. We provide more description of necessary program design elements in our recommendations section. We would also note that in preparing this estimation, we make no assertion that prepay should necessarily qualify as a conservation improvement program in Minnesota.

We developed two scenarios (Table 8).

Table 8. Description of assumption for Program One and Program Two

Scenario	Program One	Program Two
AMI	In place	In place
Selection	Voluntary / Opt-in	Voluntary / Opt-in
Savings from disconnection	Savings from disconnections are excluded from final evaluation	Savings from disconnections are excluded from final evaluation
Disconnection	Upon reaching a $0 balance, customer receives notification of imminent disconnection. Disconnection occurs at the next legally permissible time	Upon reaching a $0 balance, customer receives notification but continues to receive electricity for a short grace period. After grace period, customer is transferred to a postpay plan
Feedback	High levels via an in-home display, smartphone app, text message, or website	High levels via an in-home display, smartphone app, text message, or website
Savings estimate	Average of the strongest evaluations that exclude savings from disconnection	Typical savings value from customers who have participated in an opt-in program with a similar interface

Program One allows for immediate disconnect upon missed payments. Program Two carries no threat of disconnection (e.g., after a grace period, customers simply move back onto a traditional payment plan if they miss a payment). The reason behind breaking out the savings in this way is that the disconnection

threat may be a strong motivator for saving energy, and some recent program proposals have suggested removing it. While some evaluations analyzed savings excluding energy saved during disconnected times, we believe the programs' influence would be qualitatively different in a scenario without the disconnection threat. Both scenarios assume the following:

- Advanced metering infrastructure is in place.[30]
- Real-time information can be provided to the customer through several modes of communication (i.e., text, web, and phone).
- The program is voluntary or opt-in.
- The savings rate does not include savings from disconnection.

For the second scenario, we hypothesize that through high levels of feedback and engagement, we would still see energy reductions. DTE Energy Insights is a smartphone feedback app program that provides near real-time feedback on customers' usage. The initial pilot programs demonstrated electricity savings between 1.1% and 3.2% (Sussman and Chikumbo 2016). A similar study of the myMeter app also found 1.8% to 2.8% savings (Dougherty 2014). A prepay program with no threat of disconnect may function in a similar way; however, we feel this area is one where further research would strengthen the ability to produce useful estimates.

We determined our baseline energy consumption from residential sector values recently developed for the Minnesota Demand Side Potential Study as shown in Table 9. Without research that substantiates the specific ways participants reduce energy, we assume that savings can be achieved across all end uses.

The Program One savings rate is derived from an average of the strongest evaluations that control for savings from disconnect. The savings rate for Program Two is based on a typical savings value from customers who have participated in an opt-in program with similar interface, such as the DTE Energy Insights or myMeter smartphone feedback app (Sussman and Chikumbo 2016; Dougherty 2014).

In both scenarios, we assume that every Minnesota utility would offer a prepayment option as an opt-in program. Because of the opt-in nature, the assumed participation rate is low (1%) across all state utilities. The participation number for both programs is based on the participation rates of the only Minnesota utility with a prepayment option (around 400 out of 40,000 members; E. Webster, Vice President Corporate Services, MVEC, pers. comm., June 15, 2018). Other utilities have seen participation rates closer to 5%.[31] Absent other Minnesota-specific data on similar levels of participation, we kept our assumption at a conservative 1%.

[30] At this time, this may be the most significant infrastructure hurdle facing the state. According to the US Energy Information Administration (EIA), less than 20% of residential Minnesota customers had smart meters installed as of 2016.

[31] This was reported by a prepay advocacy organization, DEFG, webcast on July 18, 2018.

Table 9. Annual energy reduction estimates and assumptions

Scenario	Baseline residential energy consumption (GWh)	Annual usage reduction	Total potential statewide annual savings (GWh)[32]
Program One: Customers can be disconnected after payment lapse	10,627	8.5%	9 GWh
Program Two: Customers will not be disconnected after payment lapse but moved to traditional payment plan	10,627	2%	2.1 GWh

[32] This assumes a 1% statewide participation rate. The preceding text presents additional reasoning behind that assumption.

Recommendations

Given the current state of knowledge, to say whether prepay plans should qualify as energy efficiency under Minnesota's conservation improvement programs would be premature. The number of North American prepay program evaluations is insufficient, and they do not adequately explain why consumers save energy. Some prepay elements that may reduce consumption, such as feedback about use, could potentially be implemented in postpaid programs. Other prepay plan aspects that may negatively affect consumers, such as rapid shutoff, could be removed. However, current evaluations do not attribute savings to features that are not unique to prepay (such as feedback) or potential saving levels without the shutoff threat. Prepay programs save energy possibly due to the entire suite of behavioral influences working together. More research is needed to support this conclusion.

Our Minnesota utility interviews reveal considerable interest in prepayment program concepts. A well-designed pilot program could be a first step to addressing questions and determining whether prepaid electricity plans could be implemented as energy efficiency programs. Should a Minnesota utility be interested in launching a prepaid electricity pilot program, they should design it with consideration of (1) consumer protection issues and (2) evaluation of individual components of the program.

A Framework for Designing a Pilot Program

When designing a prepaid electricity pilot program to encourage energy efficiency, the pilot should both test the importance of key elements and incorporate known structural energy efficiency measures. The pilot program results can help identify which program elements can and cannot be eliminated while still maintaining energy savings. We therefore make recommendations regarding (1) implementation consultations, (2) research design methods, (3) regulatory considerations, and (4) cost-effectiveness evaluations.

Implementation Decision Making

Implementing a prepay electricity program comes with a host of technical, social, and monetary issues that are important to consider. Each of these issues involves stakeholders (e.g., utilities, consumers, and local government agencies) with diverse and equally important perspectives. Prepay pilot programs often fail regulatory review because they have not adequately considered the perspectives of all stakeholders.

One of the most important stakeholder groups is consumers, who are often represented by consumer advocates. Consumer advocates suggest that prepaid electricity programs should always be voluntary (even for consumers with arrearages or severe budget constraints), should not be more expensive than postpay (and arguably should be cheaper), should allow for bill assistance programs to be maintained (e.g., LIHEAP), and should be subject to the same consumer protections as postpay plans (e.g., no disconnections on extremely hot or cold days). Appendix D provides the National Consumer Law

Center's (NCLC's) complete list of consumer protection recommendations for prepay programs, many of which are addressed in new utility prepay pilot proposals.

Some US not-yet-public prepay programs have been recently proposed (and withdrawn) with alternatives to automatic shutoffs, such as reverting customers to postpay after a short grace period of non-top-ups.[33] Others have implemented a no-fee policy (e.g., no third-party vendor fees, reconnection fees, or deposits). In other regions of the world, some governments mandate that prepay plans have discounted kWh rates (usually 2% lower than postpay; e.g., Ireland and Bangladesh; Esteves et al. 2016; Darby 2006).[34] Minnesota stakeholders can consider these policy options for prepay. However, energy savings impacts have yet to be tested and measured under these modified consumer protection conditions.

Utilities offering rate-payer-funded efficiency programs have an additional set of concerns—that efficiency programs demonstrate cost effectiveness. Although preliminary studies indicate that prepay may increase utility profits, utilities may also need to consider upfront investment costs. This issue has come up during some prepay regulatory hearings. To date, only one evaluation we reviewed measured cost effectiveness (APS 2015), and it reported a cost-benefit ratio of 1.03.

We recommend convening a stakeholder advisory group to meet, discuss issues, and propose solutions. This step will adequately consider all stakeholders and viewpoints regarding a prepaid electricity pilot program. Consensus from all stakeholders would be a key piece of the program design process. Stakeholders should include representatives of utilities, consumers, and local government and other experts, such as academic researchers or evaluators.

Research Design

Another key piece of the design process is hiring a third-party evaluator to inform the program design. This dedicated neutral organization is critical to determine the nuts and bolts of program design and evaluation elements that will yield statistically significant and defensible results, such as sample size, duration, and methods. Ensuring neutrality is important for credibility and quality of the final program evaluation.

All acceptable programs must be designed with evaluation in mind. The evaluation should test the hypothesis that prepay electricity programs cause consumers to change behavior and reduce consumption in appropriate, measurable, and cost-effective ways. In other words, the evaluation should test whether the program influenced customers' electricity usage. However, to properly consider whether a prepay program is suitable for use as an energy efficiency program under CIP, the evaluation should do more than simply answer this question. The evaluation should also identify why these savings are likely to have occurred (i.e., isolate specific effects of elements such as feedback and disconnection)

[33] The authors of this report have been contacted to discuss these proposals, but were not authorized to present them publicly.

[34] The rationale for this decision is that utilities benefit financially from moving customers onto prepay and should, therefore, pass those benefits back to the customer.

and should provide information on what customers do that results in reduced usage (e.g., install EE measures, engage in constructive behaviors to reduce waste, or engage in actions that represent deprivation or reduced quality of life). The results should come from a large enough and appropriately representative sample, over a sufficiently long period, to be both accurate and generalizable. Due to real-world constraints, one pilot program is unlikely to achieve all these goals. Nevertheless well-designed programs may achieve some of these objectives and, over time, provide sufficient evidence to understand and assess. We therefore offer a few recommendations that will help achieve as many as possible.

Sample Size

Prior to program launch, utilities should work with a third-party evaluator to determine the appropriate sample size. The sample size is critical to this evaluation as it will determine the power of the program to find a statistically significant result. The sample-size calculation will be affected by several factors. Each additional study group will require more participants, but more consumption data per participant will reduce the number of required participants (e.g., fewer participants are required if each is able to provide 12 monthly bills as opposed to one annual average, or 24 monthly bills as opposed to 12 monthly bills). Utilities should assume that some participants will drop out of the program before the pilot is complete and therefore recruit more than are needed for the final analyses. In one evaluation, the implementer noted a 26% attrition rate (Duke Energy Carolinas 2017), which supports the suggestion to over-recruit for a study.

Control and Comparison Groups

The third-party evaluator should suggest an appropriate pilot program control group to determine whether the prepay electricity program (as opposed to other factors, such as changes in weather or economic conditions) caused a change in electricity use. Allowing only two groups (customers with prepaid electricity and control customers with postpaid electricity), as some previous programs have done, enables evaluators to learn whether customers on a complete prepay program consume less electricity than customers on a standard postpay arrangement. However, it does not inform evaluators about other important questions regarding what program features are affecting behavior. By including additional comparison groups, evaluators can learn about these specific issues.

A pilot prepay program can include several potential comparison groups in addition to customers on standard prepay and postpay plans. As more of these groups are included, the results become more informative. Additional comparison groups to consider include

- Postpay plan customers receiving feedback equivalent to prepaid customers (e.g., an app or in-home display that counts down remaining electricity to a set goal or average monthly level using effective metrics and empowering messages)[35]

[35] The type of feedback to include is discussed in greater detail in the *Feedback* subsection of this report (found in the *Prepay Electricity Impact on Energy Use* section).

- Prepay plan customers with an alternative to immediate shutoff (e.g., move to postpaid after a grace period or pay a higher rate to top-up if account goes to $0 balance)
- Prepay customers with an automatic top-up option (autopay)
- Prepay customers who specifically qualify (and do not qualify) as low income[36]
- Prepay customers receiving physical efficiency measures such as low-cost home energy kits (with faucet aerators, LED bulbs, and so on) to enhance the energy efficiency aspects of the program (particularly for low-income participants)

Quasi-Random Design

Key to the control and comparison groups is that they are appropriately equivalent to the intervention group. That is, members of these groups should be as similar to the members of the primary prepay group as possible. That way any difference in electricity consumption can be attributed to the differences between programs (and specifically the elements within them). One major problem with most studies featuring nonrandom control groups is self-selection bias. This occurs when customers self-select into the intervention and any reduction in consumption could be attributed to some inherent characteristic of the participants rather than to the program (e.g., they are the type of people who would reduce their consumption anyway).

One South Africa evaluation eliminated self-selection bias by only including participants who were involuntarily enrolled in prepay. Ethical implications make this approach untenable in North America. We recommend using a wait-list control procedure instead. Using this procedure, a limited number of customers interested in the prepaid payment option would be allowed to enroll. Once that maximum participation level is reached, subsequent customers requesting to enroll would be informed that enrollment is full for the year, but they could be enrolled later. In the interim, they could participate in the study as control group customers. These customers in the control group could be provided with incentives to participate in the study, such as entering them into a drawing or some sort of honorarium. Depending on the program design (and future evaluation requirements), they could be offered a free home energy kit or a device that provides energy use feedback (equivalent to prepay).

Customers who are enrolled in the prepaid group could then be randomly assigned to receive the traditional prepay plan or one of the alternative prepay plans described.

Should this quasi-random assignment procedure be unfeasible, program designers could consider using a matched control procedure. This may offer marginally weaker evidence but nevertheless a useful piece of information regarding prepay electricity savings.

[36] Comparison groups composed of various demographic segments, such as low income, are not assigned into those groups like other comparison conditions. Instead they are duplicates of other conditions but containing only group members with those specific demographics.

Outcome Measures

Although customer electricity usage is the most important outcome measure with regard to consumption, surveys and interviews with customers will be important for understanding consumer responses and whether the program causes deprivation. Utilities should work with the third-party evaluator to design unbiased, informative, and transparent surveys.

Regulatory Considerations

As explained earlier (and in Appendix C), no prepay electricity programs to date have been proposed primarily as energy efficiency programs. They are proposed as utility offerings that provide bill payment options for customers, offer debt recovery options, increase consumer choice, and meet utility obligations to leverage AMI installation. Because prepay programs have implications for factors such as billing procedures and shutoff protection rules, the Minnesota Public Utilities Commission would need to be involved in decision making regarding any prepay pilot proposal. Should a prepaid electricity program be proposed as an energy efficiency program under CIP, then the Department of Commerce would also be involved in considering whether that proposal was appropriate under the CIP statute and framework. A utility interested in proposing a prepaid electricity program as part of CIP would need to coordinate the application with each of those Minnesota regulatory bodies.

Cost-Effectiveness Evaluations

Determining the cost effectiveness of prepaid electricity programs can prove challenging because costs and savings are not always directly related to the same budgets within an organization. For example, upfront investment in prepay software may come from a capital investment budget, whereas benefits from decreased arrearages and fewer nontechnical losses may go to operational budgets. Furthermore, nonmonetary benefits such as call center morale and nonmonetary costs such as health risks to customers are difficult to quantify. See Table 5 and Table 6 for our list of potential costs and benefits.

Program planning should involve preparing for evaluation of both monetary and nonmonetary costs and benefits. In Minnesota, this specifically means assessing the costs and benefits to society, the utility, and the participant. The societal costs and benefits are of particular interest and importance for evaluation of Minnesota utility programs.[37] To date, only one of the reviewed North American evaluations assessed prepay costs and benefits (APS 2015). It did not include an assessment of societal costs and benefits.

[37] For more details, see Minnesota Department of Commerce website or refer to the recently developed *National Standard Practice Manual*.

Other Program Design Considerations

In addition to the high-level design, evaluation, and regulatory considerations, utilities considering a prepay pilot program will need to navigate the on-the-ground details of implementing a radical new customer-facing program.

Effective customer outreach and communication are essential for ensuring transparency and understanding. Nearly all the research we reviewed (peer reviewed and proprietary) suggests that customers like prepay services. Nevertheless the costs and risks may be higher for prepaid customers. Thus utilities must carefully plan and budget for a communication campaign that explains the potential benefits of prepay, while also educating customers on potential drawbacks. These could be large-scale media campaigns or direct marketing to target customers, or a combination of both. A discussion with stakeholder groups as well as communications specialists (well before the campaign) could ensure a smooth pilot program launch.

Given the radical shift in the fundamental process of notification and payment, utilities should plan to receive initially higher volumes of customer questions about the service. This may require specialized call center training and additional staff. Some reports from prepay advocates suggest that call center complaints may decrease over time to below baseline and may become less severe.

The new payment system will also require technological enhancements to databases and payment systems. Accuracy and reliability of these systems are vital to the success of the program. If the new system does not work correctly, then customer complaints will increase, trust will erode, and enrollment will decrease.

Summary and Conclusions

Minnesota's decision as to whether prepaid electricity plans could be used as energy efficiency behavior change programs rests on a combination of three interacting elements:

1. The program's ability to cost-effectively reduce electricity consumption
2. Program elements that cause electricity reduction
3. The nature of the customer actions that result in the usage reduction (i.e., reducing consumption without reducing level of service)

Previous evaluations suggest that electricity consumers likely use less electricity if transferred to prepaid electricity plans. However, this effect may be in part due to factors that reduce customer quality of life, such as going without electricity more often, or to factors that can be easily applied to postpaid programs, such as feedback.

Programs that optimally address the possibility of consumer deprivation may reduce potential energy savings. When the risk of shutoff is removed and costs are reduced, consumers (especially low-income consumers) will be better protected, but electricity savings may decrease or become nonsignificant. More research is needed to determine the impact of removing shutoffs and changing pricing in prepaid program designs and energy savings calculations.

In examining previous research, assessing current evaluations, and interviewing diverse groups of stakeholders, the clearest conclusion is that more research is required to understand how prepay programs work in North America. Minnesota utilities interested in conducting pilot prepay programs can help fill this knowledge gap. While we neither endorse nor condone prepay electricity programs, we offer a program design framework for interested utilities that addresses consumer deprivation concerns and provides answers to key program questions. Any such effort would have to be compatible with the applicable Minnesota regulatory framework.

Prepay electricity offers a possible additional payment option for Minnesota consumers—one that has the potential to change behavior and reduce energy consumption. We recommend that more research be conducted on this new type of program.

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Appendix A: Interviews

Interviewees

Mattias Bell, Xcel MN
Raquel Berg, Connexus
Todd Berreman, Centerpoint
Mark Brown, MyMeter
Jessica Burdette, Minnesota Department of Commerce
Elizabeth Chant, Independent Consultant
Liz Coyle, Georgia Watch
Dave Elve, PayGo
Rob Elwood, Minnesota Legal Services Advocacy Project
Pamela Ferris, Texas Ratepayers' Organization to Save Energy (ROSE)
Anthony Fryer, Minnesota Department of Commerce
Jason Grenier, Ottertail Power
Diana Hernandez, Columbia University
Ed Houn, MyMeter
John Howat, National Consumer Law Center
Kelsey Jack, Tufts University
Tina Koecher, MN Power
Bill LeBlanc, ESource
Kim O'Sullivan, Otago University (New Zealand)
Nick Mark, Centerpoint
Geoff Marke, Missouri Office of Public Council
Kristen Munsch, Citizens Utility Board of Illinois
Laura Silver, Minnesota Department of Commerce
Eddie Webster, Minnesota Valley Electric
Jamie Wimberly, Distributed Energy Finance Group (DEFG)
Cynthia Zwick, Arizona Community Action Agency (ACAA)

Interview Procedures

For each interview, we used a set interview methodology. We began the interviews by explaining the purpose of the project, funders, and project goals. We then asked each interviewee a set of predetermined questions:

1. Please describe your knowledge and/or experience with prepay electricity programs. What do you think about them generally?
2. In our report, we are aiming to paint the picture of the pros and cons of prepay programs. Could you please describe what you consider to be the benefits and what you perceive to be the concerns regarding prepay?
3. In your experience, how have you seen customers react to prepay programs?
4. What are your thoughts on using a prepaid electricity plan as a method to encourage people to save energy?
5. Are you aware of any evaluation reports on prepay pilot programs that would be useful for us to explore in our research?
6. Do you think prepay programs should be implemented at a large scale? What are the barriers that prevent prepay programs from being more widespread today?
7. (*Optional question for utilities with programs*)
    a. If you count energy savings from your program, how do you count it? Do you use third-party evaluators? Do you have evaluation reports that you could share with us?
8. (*Optional question for Minnesota stakeholders*)
    a. Do you think prepay is a viable option for utilities in Minnesota, either as a payment option or as an efficiency measure? What are some key considerations?
9. Do you have any final comments or thoughts you'd like to share with us?

Summary of Themes from Interviewees

We reviewed the main arguments and statements from the interviews and developed summary tables of interview themes that are more in-depth, relative to the single table presented earlier in the report. In addition to the four themes summarized in the table earlier in the report (research, customer, utility and consumer protection), these tables also include program design. We indicate in the tables the type of stakeholder that brought up each issue, but we do not attribute sentiments directly to interviewees, for confidentiality.

Table 10 summarizes themes related to the category of research.

Table 10. Summary of themes from interviewees on topic of more research needed

Interviewee type	Main point/findings on topic of more research needed
Academic	We need more research to determine why customers are saving energy on prepaid meters and distribution impacts on rich versus poor customers.
Academic	It is important to collect information on self-disconnection stats to track who is being affected and how long people are without electricity (either voluntarily or nonvoluntarily).
Prepay advocate	Interviewees agree that we need more experiments that look at the impacts of shutoffs, financial penalties, and reward/price scenarios; prepay does clearly save energy, but we need more research to determine why this is the case.
Consumer advocate	Interviewees do not believe that prepay pilot programs as research are ethical.
Consumer advocate	Evaluations for prepay programs are not strong enough to call prepay energy efficiency.
Consumer advocate	We need research to determine whether shutoffs are voluntary or not, and if they are involuntary then they should not be counted as efficiency in studies.
Consumer advocate	We need research that breaks down savings from each measure to show what causes savings.

Table 11 through Table 13 summarize themes related to the category of customers.

Table 11. Summary of themes from interviewees on topic of customer satisfaction

Interviewee type	Main point/findings on topic of customer satisfaction
Consumer advocate	Customer satisfaction work is deficient; we don't see the survey questions; most in jurisdictions without bill payment programs; wants survey that asks how often people are disconnected and what that means for them, ask people if they'd want to be disconnected, and so on.
Consumer advocate	Interviewees want to look into customer satisfaction questions to make sure these surveys were completed objectively.
Consumer advocate	Interviewees mentioned customers calling into call center about positive impacts of program
Prepay advocate	Prepay provides customers a balance instead of bills. "'No more bills!' That should be the banner of prepay programs."
Prepay advocate	Prepay programs provide 21st-century service (rather than a second-tier service that some advocates claim it is).

Interviewee type	Main point/findings on topic of customer satisfaction
Consumer advocate	As a consumer advocate it's hard to go against how customers say they are satisfied with the programs, but the interviewee wants to ensure consumer protections are in place.
Minnesota utility	The customer satisfaction element is really compelling. It provides customers with convenience and optionality.
Minnesota utility	They think that their customers would like it. Want to give their customers options.
Prepay Advocate	Frustration because some consumer advocates don't seem to believe it—customers call the utility to thank them for providing the program.

Table 12. Summary of themes from interviewees on topic of customer control

Interviewee type	Main point/findings on topic of customer control
Prepay advocate	Prepay gives customers control over their energy use; accuses consumer advocates of eliminating choice and the ability of customers to save money and lower their anxiety about bills.
Consumer advocate	Prepay programs give customers feeling of control over their energy use; the number one reason customers give for liking prepay is that they have control over their energy use.
Prepay advocate	Prepay gives them control of their bill and surprises go away.
Prepay advocate	Prepay puts customers in control and helps them understand their kWh energy use.
Prepay advocate	Anecdotes over the past few years from customers about feeling in control and loving prepay programs; customers realize it was their fault for not paying, not the utilities fault for disconnecting them; shifting perception from utility shutting off to own fault for shutoff.
Minnesota utility	The customer satisfaction element is really compelling. It provides customers with convenience and optionality.
Academic	Research has found that customers did appreciate the increased control they had from prepay, as they could organize their finances around their energy bill using prepay; interviewees also think "forgetfulness" is a fake reason that people give for shutoffs, and it is more likely do not have the money and want to avoid stigma and shame.

Table 13. Summary of themes from interviewees on topic of customer voluntary program

Interviewee type	Main point/findings on topic of customer voluntary program
Consumer advocate	Interviewees say many people are on prepay because they do not have a choice; agreeing to be on prepay to avoid being disconnected.
Prepay advocate	If customers are unhappy, they can just go back to postpay.

Interviewee type	Main point/findings on topic of customer voluntary program
Consumer advocate	Prepay programs have a natural market, with about 20%–25% of customers saying they want to be on prepay. This isn't for senior citizens.
Minnesota utility	If it's an opt-in program, levels of enrollment are a concern. The utility already has a great portable for customers, so what else does prepay offer?
Prepay advocate	Prepay is a voluntary program with self-opt-in.

Table 14 through Table 16 summarizes themes related to the category of utilities.

Table 14. Summary of themes from interviewees on topic of utility costs (lost revenues)

Interviewee type	Main point/findings on topic of utility costs (lost revenues)
Consumer advocate	Research can help utilities determine whether they can count prepay as EE because of lost revenue through decreased energy sales.
Consumer advocate	A utility can't recoup costs from this type of program, and this consumer advocate thinks it's a distraction from other programs (like home upgrades or efficiency rebates).
Consumer advocate	Revenue decoupling could include prepay programs, not just EE programs; this would allow prepay to not be EE while addressing this issue.
Prepay advocate	Some larger utilities are concerned about the revenue lost from prepay programs, if they can't count prepay as EE.

Table 15. Summary of themes from interviewees on topic of utility savings

Interviewee type	Main point/findings on topic of utility savings
Minnesota utility	The utility doesn't end up paying for bad debt that customers can't pay.
Consumer advocate	It may be important to look into differences in motivations for co-ops, munis, and IOUs to run prepay programs.
Minnesota utility	Utilities are interested in knowing cost effectiveness.

Table 16. Summary of themes from interviewees on topic of prepay as a utility efficiency program

Interviewee type	Main point/findings on topic of utility efficiency program
Consumer advocate	Generally, prepay programs are a payment program (like time of use) and should not be considered the same as a typical EE program.
Minnesota utility	It would be great if utilities could count savings from prepay.

Interviewee type	Main point/findings on topic of utility efficiency program
Minnesota utility	The holy grail is how to not cannibalize the traditional EE offering. Asset-based programs are diminishing. The baseline is becoming higher. We need to be exploring innovation programs.
Consumer advocate	While prepay does lead to energy savings, nothing has proved that customers are changing their behaviors to save energy; Interviewees are unsure whether any energy efficiency education is included with prepay programs.
Consumer advocate	Does not think prepay should be an EE program measure.
Consumer advocate	Utilities need to conduct cost-benefit analysis to determine whether the costs are low and benefits high or vice versa; prepay needs to be comprehensive, but overall we need more robust research.
Academic	While people on prepay may use less energy, programs should couple behavioral changes with physical EE changes; sometimes people are forgoing basic needs to save money and energy—need more research.

Table 17 through Table 19 summarize themes related to the category of consumer protection.

Table 17. Summary of themes from interviewees on topic of general consumer protection concerns

Interviewee type	Main point/findings on topic of consumer protection concerns
Consumer advocate	We need to “first do no harm” with prepay, make sure all consumer protections are in place.
Academic	Prepay is a good option when strong consumer protections are in place; above 12 hours regularly shut off is problematic for people (e.g., freezer defrost, pipes bursting).
Academic	Public health perspective: detrimental to not have electricity at home, behavioral challenges for children and child protection services.
Consumer advocate	Costs of communication: Who is picking up the costs of the texts for communication and other costs? Program should be less expensive for participants, not more expensive; SRP doesn't allow shutoffs at night; customers need to be able to take advantage of bill assistance programs while on prepay.
Minnesota Utility	We want to make sure that the right processes/mechanisms are in place for prepay to meet the requirements of consumer protections.
Minnesota Utility	Would like a program that is fair and equitable, and they do not want to only target low-income customers.
Consumer advocate	Consumer protections are in place with regulated utilities. Prepay programs often ignore consumer protections (i.e., disconnect rules).
Consumer advocate	In Texas, customers can split deposit payments to better afford them; utilities can find better ways to collect “uncollectables” than through prepay.

Table 18. Summary of themes from interviewees on topic of consumer protections and disconnection as a main motivator for energy savings

Interviewee type	Main point/findings on topic of disconnection as motivator
Academic	People will likely reduce energy without disconnections if they have feedback, but it would likely not be as effective as with disconnections.
Consumer advocate	Disconnection is the core issue: customers can receive feedback and other benefits on other payment methods; customers can also pay in advance now if they want to; impact of disconnection is larger than just the time customer is disconnected; also must account for other societal costs (e.g., refrigerator food loss).
Consumer advocate	This consumer advocate would not support prepay if it includes the threat of disconnections.
Minnesota utility	We would not want to run a program that has disconnect, but even without the threat of disconnect, a pay-as-you-go program would keep the customer engaged for savings.
Minnesota utility	What would be the motivation to save energy without a disconnect fee?
Consumer advocate	Advocates used to be more concerned about disconnects, but now if they have the possibility to get turned back on quickly and are given adequate warning they are not as concerned; customers need constant communication through in-home display or apps to be aware of pending disconnects
Consumer advocate	Customers say they are positively lowering their energy bills, taking control of energy use; consumer advocates are interested to see whether this is due to fear of shutoff or better education/feedback.

Table 19. Summary of themes from interviewees on topic of consumer protections and equity concerns

Interviewee type	Main point/findings on topic of consumer protections and equity concerns
Consumer advocate	When shutoff notification relies on electronic notification this can be problematic (if didn't pay utility bill may not have paid phone or Internet bill); California did not approve because of shutoff.
Academic	For MPower program in Arizona people frequently experienced shutoffs, didn't have many places to top-up their cars, many didn't have car so had to use public transit; stress associated with prepay, parental self-efficacy challenged, thermal comfort issues, and security and health issues. In Phoenix, housing policy is that high arrearages can affect housing stability; prepay allows people to not gain arrearage and have stable housing.
Academic	Race and affordable rates are issues of concern, should be correcting energy burdens, cash-based economy, top-up fees.
Consumer advocate	"It's baloney that they aren't targeting low-income."

Interviewee type	Main point/findings on topic of consumer protections and equity concerns
Consumer advocate	If customers want choice, then why are programs only targeting low-income customers and not all customer classes; prepay needs to be truly free choice for low-income (not coerced into program due to high deposits or arrearages)
Minnesota utility	Interviewee does not want to explicitly target low-income customers but thinks it could benefit the customers —their own customer research suggests that low-income customers don't like to be surprised by their bills. They don't have the flexibility if they have a bigger bill one month. Could be a benefit rather than a stick because of the transparency.

Table 20 through Table 24 summarize themes related to the category of utility program design.

Table 20. Summary of themes from interviewees on topic of program design and the importance of program structure

Interviewee type	Main point/findings on topic of program design and importance of program structure
Consumer advocate	The main issues with prepay depend on program structure; prepay programs need to include in-home display (with minimal cost to participants), ability to pay with cash, low or no fees for credit card payments, reduced expense (cash avoids fees), second-tier usage ability (turn off some parts of home when money is low), ability to build some arrearages during protected shutoff times; program design is key to success of the program from customer use and company perspectives.
Minnesota utility	For a prepay program to work well, you need a strong communications plan for customers. Need the infrastructure and process for when the prepay technology isn't working perfectly … and it won't always work perfectly.

Table 21. Summary of themes from interviewees on topic of program design and ideas for prepay pilots/program models

Interviewee type	Main point/findings on topic of program design and ideas for prepay pilots/program models
Academic	Consider programs with no disconnections or cheaper electricity if you pay on time or threat of price penalty if you don't.
Consumer advocate	Study the prepay shutoff rate compared to non-prepay program shutoff rates; don't want people to save energy from being shut off.
Consumer advocate	Programs could offer rewards to customers who pay in advance (instead of disconnection) or offer lower rates to those on prepay.
Academic	MPower program has higher rates for prepay; most customers know this and still decide to be on prepay!
Consumer advocate	Rates should be lower for prepay to account for utilities receiving money before providing service.

Table 22. Summary of themes from interviewees on topic of program design and barriers to prepay

Interviewee type	Main point/findings on topic of program design and barriers to prepay
Prepay advocate	Utilities don't like fighting with interveners, utilities don't like altering billing software due to fears around security, and they need more evaluations like APS.
Prepay advocate	One roadblock is consumer advocates and regulators putting the brakes on programs; some utilities don't want to fight the battle that has been out there, some states like California had consumer advocates go to "open warfare" against prepay.
Minnesota utility	People need to overcome the stigma of prepay and the "sins of the past." Prepay has evolved from where it has started, but it's constantly anchored to the past.
Consumer advocate	Concerned about natural gas prepay programs because they are not regulated the same way as electric, may have fewer protections.

Table 23. Summary of themes from interviewees on topic of program design and natural gas considerations

Interviewee type	Main point/findings on topic of program design and natural gas considerations
Consumer advocate	AMI roll-out could be of concern in MN. Minnesota should talk with CAAs who administer LIHEAP and WAP and DHS to understand low-income customers in the state and how prepay could impact.
Minnesota utility	Not planning on rolling out AMI in the near-term. To install AMI for just prepay option does not seem feasible. Shutting off gas customers has a safety aspect concern—when the gas gets turned back on, a way must be devised to make sure pilot lights are lit again.

Table 24. Summary of themes from interviewees on topic of program design and Minnesota-specific ideas

Interviewee type	Main point/findings on topic of program design and Minnesota-specific ideas
Department of Commerce	Looking for a framework that can be applied to the 130 utilities, including how to best evaluate savings and what happens to people that can't pay or may have safety/comfort compromised.
Minnesota Utility	While this utility doesn't have AMI in place, it's planning for it in the future. They are looking for direction from the Commission.

Appendix B: Prepay Elements That May Cause Energy Reduction

Feedback

A full discussion of the effects of feedback is presented within the body of the report, in the section Prepay Elements That May Cause Energy Reduction.

Fast Shutoff

One of the most controversial differences between prepay and postpay electricity plans is the promptness of electricity service disconnection. As we discuss in the *Prepay Considerations from Opponents and Advocates* section of this report, this is often the primary reason that utility regulators choose to disallow implementation of prepay electricity programs in the United States. Unlike postpay plans, in which consumers have several weeks to pay their bills and several more weeks of accumulating debt and interest before being disconnected, consumers on prepay plans are usually disconnected within about one day of running out of electricity credit. Although regulations usually stipulate when prepay customers cannot be disconnected (e.g., overnight or on extremely cold days), outside of these times the practice is to disconnect shortly after the customer runs out of credit.

The debate regarding whether this is good or bad for consumers (and particularly low-income consumers), and whether electricity should be bought and sold like most other products instead of paid for after use, is one that needs more exploration. We defer this debate to the *Concerns of Advocates and Opponents* section of the report and focus here on whether immediate shutoff may be an element responsible for changing participant behavior and reducing electricity use in prepay programs.

Some evaluations of prepay programs in Table 3 find that customers reduce consumption even after excluding reductions from disconnections. That is, the energy saved from disconnecting customers is not included in the overall accounting of energy reductions from prepay. The practice of excluding energy saved from so-called self-disconnections is sometimes debated because voluntarily disconnecting services may be used by some customers as a measure of controlling consumption and bills (Mummery and Reilly 2010). Regardless of whether these savings are accounted for in program evaluations, the looming threat of immediate shutoff could be enough of a motivator to encourage electricity conservation behavior.

Some of the earliest studies in psychology reveal that punishment reduces the occurrence of future behavior (e.g., Skinner 1953). Importantly, punishments will only be effective if they are meaningful to the recipient and strong enough to be noticed. The removal of electricity services is what Skinner might call a negative punishment and one that, unlike other strategies used in energy efficiency behavior change programs, is particularly meaningful and potent. Thus, at least theoretically, prepay may reduce

energy because it includes an efficient punishment mechanism for not topping up one's electricity credit.

Some evidence regarding the potency of electricity shutoff to change behavior comes from research on how low-income residents manage their finances. Interviews with 194 heads of lower-income households in Boston and Champaign-Urbana revealed that debt juggling was the most frequent strategy for managing expenses, especially among those with the lowest incomes (Tach and Greene 2014). These residents generally put off paying expenses such as bills and debts until they pose an immediate threat to well-being.

The most urgent needs come first. As one interviewee explained, "Rent comes before everything and I mean as long as my kids have food and clothes on their back and stuff, you know, I don't—I try not to stress myself out thinkin' of those things [bills] because right now at this point in time like I can't just even prioritize a bill because it's like I really have no income comin' in" (Tach and Greene 2014, p. 13). Thus, interviewees would take advantage of the ability to accumulate debt rather than pay bills to pay for other urgent needs. Without this ability to defer payment, electricity shutoff would become more urgent and consumers might be more likely to raise the importance of paying for electricity bills to avoid the punishment of reduced well-being.

O'Sullivan and colleagues (2014) found that prepay program participants prioritize electricity purchases highly (just after rent/mortgage payments) and that they are relatively good at budgeting (and even planning for seasonal changes in electricity use). Prepay forces consumers to avoid accumulating debt from unpaid bills and instead purchase electricity before using it. Whether this is good or bad for short- and long-term quality of life is discussed in the *Advocates and Opponents Concerns* section of this report. Regardless, this element of prepaid electricity plans could be one of the causes of reduced electricity consumption.

Cost

Although most American prepay programs that are currently offered or planned have similar built-in costs for prepay and postpay customers (N. Treadway, Managing Partner, DEFG, pers. comm., July 12, 2018), hidden costs can still make prepay slightly more expensive in some cases. For example, Salt River Project's M-Power program—the most well-documented US prepaid electricity program, available to customers in Phoenix, Arizona—has similar electricity rates for prepay and postpay plans and requires a smaller deposit for activating prepay service than for postpay, but 40% of any prepay top-up payments must go to paying down arrears (EPRI 2010). Although this may be a benefit, given that many consumers who switch to prepay owe arrears, a large proportion of prepay customers had to pay more to get the same amount of electricity (because the first 40% went to paying down arrears). This reduction of access to electricity could have impacted their disconnection rates and electricity usage.

Similarly, some programs ask participants to pay a small fee for adding credit at a kiosk, by a third-party vendor (e.g., by credit card or check), or over the phone (Howat and McLaughlin 2012). Although these transaction fees may be identical to postpay fees, they are cumulatively higher for prepay consumers

because prepay consumers are likely to engage in a larger number of transactions (Howat and McLaughlin 2012).

In South Africa, although program fees were identical between prepay and postpay and debt repayment was not required for most customers on prepay, some customers were moved onto a higher electricity rate for about three months after installation of prepay meters, and this could account for a small percentage of the savings from the program (Jack and Smith 2016).

Low-income prepay customers have, in some studies, expressed willingness to accept the higher costs of prepay programs because they believe the benefits outweigh these costs (e.g., O'Sullivan et al. 2013), but these costs may influence behavior. Traditional economic theory explains that when costs rise, consumption decreases. We would be interested to see whether prepay programs reduce energy consumption in countries such as Bangladesh or Northern Ireland, where prepaid electricity costs are lower than postpay costs.

Usually Frequent Payment

One way to encourage behavior is to make the opportunity to act more convenient or make the converse action less convenient. For example, stair use can be encouraged by slowing elevator doors or situating the stairs within line of sight of the elevator (Van Houten, Nau, and Merrigan 1981; Bungum et al. 2007). Recycling is more likely when the recycling bin is beside the garbage bin, close to where consumption of recyclable goods occurs (e.g., Ludwig, Gray, and Rowell 1998). The effort required to pay for electricity could affect its use.

Prepay customers generally pay for electricity with smaller and more-frequent payments. In itself, this could increase the chances of missing a payment by chance. If a program also requires an inconvenient method of payment, then this effect is multiplied. For example, the Salt River Project evaluation was conducted at a time during which participants had to travel an average of two to three miles to a kiosk to purchase electricity credits (Qiu, Xing, and Wang 2016). Given that they purchased credits an average of three to four times per month, this small but significant burden may have influenced consumption (and disconnection rates, which were not accounted for) in this evaluation.

Modern American prepay programs are based on smart meters and often offer payment options that are more convenient than those for many postpay programs (e.g., the ability to top-up credit by phone app at any time for any amount). DEFG's market research shows that convenience is among the top reasons that potential consumers are interested in adopting modern prepay plans. These newer programs and the element of convenience/inconvenience should be evaluated. Whether electricity savings remain equally high for programs with convenient payment options would be interesting to see.

Active Payment

Individuals who must actively decide how much credit to add to their electricity account may subsequently pay more attention to the electricity they are using. Most prepay customers purchase electricity credits 3 to 9.5 times as frequently (3 to 9.5 times per month, depending on the program) as postpay customers pay their bills (Qiu, Xing, and Wang 2016; Jack and Smith 2016). These participants choose when to load credit onto their accounts and how much to load. This increased attention and decision making may subsequently lead participants to pay more attention to how much electricity they are using.

Evidence of the process of active decision making to change behavior can be found in studies of 401(k) deposits (Carroll et al. 2009). New employees who are forced to choose whether to enroll in a 401(k) savings plan upon being hired are significantly more likely to enroll (28% more likely) than those who are not forced to choose one of the two options. They then make higher savings contributions and save more money. Without active decision making, many employees procrastinate and make poor financial planning decisions by default.

Active decision making as a potential influence on the behavior of prepay program participants should be studied directly within a North American context. One report on Chinese prepay programs found, surprisingly, that customers on autopay did not use significantly more electricity than those on prepay, but the authors used a bottom-up estimation of energy use as opposed to actual monthly billing data (Du, Guo, and Wei 2017). The Chinese context is also different from the modern American context for several reasons. Among other things, many residents in rural China do not have electricity, and 54% of customers still pay their bills at the counter of the electricity company. They thus engage with their bills more deeply than North American consumers who, if not using autopay, tend to pay online or over the phone. Although active payment may account for only a small proportion of the effect of prepay programs, this potential influence on behavior should be tested.

Paying in Advance

One final required aspect of prepay electricity programs is that consumers must pay for their power in advance of receiving it. This characteristic of prepay programs may increase the attention and concern that consumers pay to their usage. Consumers that delay payment for electricity are using credit to pay their bills. Classical economics research finds that consumption tends to increase as access to credit increases (Ludvigson 1999), and people are willing to pay more for goods using a credit card than using cash (Prelec and Simester 2001). Similarly, restaurant-goers leave larger tips using credit cards than using cash (Feinberg 1986). This increase in spending using credit cards is partly explained by access to credit (Ludvigson 1999) and partly by other mental processes that are not entirely clear (Prelec and Simester 2001).

Loading up prepay meters in advance of using the electricity is like the process of getting cash from the bank before spending it. Conversely, paying for electricity after using it is similar to spending credit and

then paying the balance later. The same mechanism that works to reduce spending with cash may also work to reduce spending on electricity for prepay program participants. Although this effect may be limited, it is an important potential mechanism to test because it is the most fundamental to prepaid electricity plans (and strongly differentiates them from postpay plans).

In line with the results of several studies (e.g., APS 2015, Jack and Smith 2016), this effect may be most pointed for low-income customers. At least one study suggests that people with less money continue thinking about the costs of products, even after buying them, whereas wealthy people only think of those costs at the time of purchase (Shah et al. 2018). For wealthy people, consuming a product that was paid for in the past is like consuming something "for free," whereas for people without money, the cost of the product is considered every time it is consumed. Thus we might expect that paying in advance for electricity would reduce consumption among people without money more than among those who are wealthy.

Appendix C: State Regulatory Orders/Actions Regarding Prepay

CALIFORNIA (SDG&E 2014)

In 2014 the California Public Utilities Commission (CPUC) ruled on a March 2012 proposal for a prepay program from San Diego Gas & Electric (SDG&E) that they claimed would have several benefits, including "potential energy savings." The prepay program was opposed by several parties, including the Office of Ratepayer Advocates (ORA), The Utility Reform Network (TURN), the National Consumer Law Center (NCLC), and so on. The CPUC ruled that it did not find the proposed program to be in the public interest, apparently on ratepayer protection grounds relating to advance notice to customers about shutoffs. The issue of energy savings did not appear to be a material factor in the decision. The commission noted that it was not foreclosing the ability of the utility to propose a prepay program in the future (although we find no evidence of any prepay program being subsequently approved).
[Decision 14-01-002, January 16, 2014]

KANSAS (Westar 2016)

In 2014 Westar implemented a two-year prepay pilot program. In November 2016 Westar applied to convert the pilot into a permanent program and remove the participation limit. Westar cited as a benefit of the program that it had collected over $300,000 in arrears from customers in the program. (We did not see any mention of energy efficiency or energy savings as an issue in the order summary.) Commission staff and a consumer group (Citizens' Utility Ratepayer Board; CURB) filed opposition to the proposal, claiming that the company had not provided any cost-benefit analysis and that the per-customer program costs were high (e.g., $850 to $1,040, depending upon what was included). The commission agreed that Westar had not presented a sufficient record to justify making the program permanent, so they denied Westar's request and gave them six months to transition current participants off the program.
[Docket No. 14-WSEE-148-TAR, December 15, 2016]

MISSOURI (2017)

In November 2017 Ameren Missouri filed an application to have a prepay pilot program approved. The proposal was opposed by commission staff as well as by the Missouri Office of Public Counsel (OPC), who argued that the program was not cost effective and would not meet the definition of an energy efficiency program under Missouri statute. In April 2018 Ameren withdrew its proposal.
[Case No. EO-2015-055]

The OPC informed us that in the recent rulemaking for the Missouri Energy Efficiency Investment Act, the definition of *demand-side programs* was updated to specifically exclude "deprivation of service" as an eligible component (Rule 4 CSR 240.20.093(1)M). This reportedly was done specifically in response to concerns about prepay.
[G. Marke, Chief Economist, Missouri Office of the Public Counsel, pers. comm., July 20, 2017]

NORTH CAROLINA (Progress Energy Carolinas 2012)
In February 2012 Progress Energy Carolinas (PEC) filed a request for approval of a prepay pilot program as an energy efficiency program. The commission noted that the utility had conducted a prepay pilot in 2001 and that the utility itself had concluded that the program was not cost effective and closed the program in 2002. For the current application, the commission concluded: "PEC has not provided sufficient information to persuade the Commission that the prepay pilot could ultimately lead to a cost-effective energy efficiency program" and denied the application.
[Docket No. E-2, sub 1011, June 13, 2012]

North Carolina Update (2018).
In January 2018 Duke Energy Carolinas filed for approval of a "Prepaid Advantage Energy Efficiency Pilot Program." Commission staff recommended disapproval of the request in a filing on April 16. Staff was supportive of some of the proposed technical capabilities being broadly available to customers but opposed categorizing prepay as an energy efficiency program. Among their concerns, an April 17 *Utility Dive* article reported: "Staff said if the program were approved, Duke would have recovered its costs in a rider proceeding and receive a bonus utility incentive, plus a net lost revenue incentive, from all customers" (Walton 2018). While disagreeing that such treatment was appropriate, staff did say in their filing: "The billing and data usage components of the Prepaid Pilot are basic functionalities of AMI meters and should not be the basis of an EE program. Customers should receive the full benefits of AMI meter functionality, including the prepaid billing option, as part of normal electric service provided under base rates" (p. 6). They went on to say: "Staff would encourage the Company to request approval from the Commission to offer a prepay billing option that is not presented as a DSM/EE program" (p. 7).

On April 26 the company requested to withdraw its application for the prepay pilot program, and on June 15 the commission issued an order granting the withdrawal.
[Docket No. E-7, SUB 1167]

OHIO (Duke Energy Ohio 2010)
In December 2009 Duke Energy Ohio proposed a $2.7 million prepay program as one of 10 proposed programs for their energy efficiency portfolio. The Ohio Partners for Affordable Energy (OPAE) argued against approval, saying that the program was not energy efficiency. In December 2010 the commission denied approval for the prepay program, saying that the utility had not provided adequate information to support implementation. The commission stated the company needed to provide more detailed information, "including but not limited to, the potential for any consumer benefits and any ancillary benefits that may accrue to Duke as a result of this program." The other nine proposed energy efficiency programs were all approved.
[Case No. 09-1999-EL-POR]

PENNSYLVANIA (PECO 2018)
In October 2016 PECO filed an application to conduct a prepay pilot program, including a waiver of several typical ratepayer protections regarding billing and shutoffs. The expressed objectives of the

company were to (1) assess customer adoption and whether it increases customer satisfaction to have an alternative available; (2) collect data of customer usage and payment patterns; (3) assess whether the plan affects reduction and avoidance of delinquencies; (4) assess whether the plan assists in energy conservation. Several ratepayer advocate groups intervened and opposed the proposal.

On March 6, 2018, the administrative law judge (ALJ) issued a proposed decision for the commission to consider. The ALJ recommended denying the proposal on a number of grounds, most relating to various ratepayer protections regarding shutoffs and so forth. The ALJ noted that "some of the problems can be resolved by not including as potential participants households under 300% of the FPL. However, this modification does not cure all of the deficiencies that I found problematic" (p. 79). Among the findings of fact was the statement that "Reduced usage from prepayment is not necessarily conservation as it could also be deprivation through forced usage reduction" (p. 21).
[Recommended Decision, P-2016-2573023, March 6, 2018]

ARIZONA (Arizona Public Service [APS] 2015)
In March 2015 APS filed for approval to continue its 2013 DSM plan through 2015 and going forward, including transitioning its pilot prepay program into a fully implemented DSM program. The pilot had been approved in July 2012, with a maximum of 2,000 customers. Staff recommended that the program remain a pilot until certain operational and scalability concerns were resolved. The Southwest Energy Efficiency Project (SWEEP) intervened and said the program should only be continued if the energy efficiency education and communication aspects were improved, and that any energy savings needed to be better documented by an independent study that was fully reviewed by the commission and a stakeholder group.

In November 2015 the commission ordered that the prepay program would stay as a pilot program, that APS shall discontinue the pilot program by December 2016, and that APS "shall work with stakeholders to collaborate on ways to enhance the education and communication offerings for potential future prepaid programs in order to increase program effectiveness to ensure that customers fully understand the program and their options for how to reduce their energy bills and also to ensure the energy savings due to the education and communication offerings are documented in a reliable manner" (p. 16).
[Docket No. E-01345A-15-0095, November 25, 2015]

(The APS prepay program is currently categorized as "suspended.")

Appendix D: Recommendations to Address Consumer Concerns

Consumer advocate groups make several suggestions to reduce the likelihood of negative quality-of-life outcomes from prepaid electricity programs (NASUCA 2011; Howat and McLaughlin 2012). Following are the suggestions of National Association of State Utility Consumer Advocates (NASUCA 2011) that were echoed the following year by the National Consumer Law Center (Howat and McLaughlin 2012).

These recommendations were made six years ago and most have been addressed in modern prepaid electricity proposals. If programs met all these requirements, they would almost certainly avoid deprivation, but they may also become less appealing to utilities in Minnesota and possibly less effective as energy efficiency programs (because they remove some of the elements that potentially cause behavior change and ensure utility revenues). We present these not as requirements, but as suggestions to consider.

- All regulatory consumer protections and programs regarding disconnection limitations or prohibitions, advanced notice of disconnection, premise visits, availability of payment plans or deferred payment agreements, availability of bill payment assistance or arrearage forgiveness, and billing disputes are maintained or enhanced
- If the billing credits of a customer receiving prepaid residential electric or natural gas service are exhausted, the customer shall be given a reasonable disconnection grace period, after which the customer shall revert to traditional, credit-based service, subject to all rules and customer protections applicable to such service
- Prepayment households include no one who is income-eligible to participate in the federal Low-Income Home Energy Assistance Program (LIHEAP) or protected under state law from disconnection for health or safety reasons
- Prepaid service is marketed only as a purely voluntary service and is not marketed to customers facing imminent disconnection for nonpayment
- Utilities offering prepaid service also offer effective bill payment assistance and arrearage management programs for all customers, including customers with arrearages who choose prepayment service
- Rates for prepaid service are lower than rates for comparable credit-based service, reflecting the lower costs associated with reduced cash working capital requirements, uncollectible amounts, and shareholder risk affecting a utility's return on equity
- Utilities demonstrate the cost effectiveness of any proposed prepaid service offerings through a cost versus benefit analysis and reveal how costs will be allocated among various classes of customers

- Prepayment customers are not subjected to any security deposits or to additional fees of any kind, including but not limited to initiation fees or extra fees assessed at any time customers purchase credits
- Utilities ensure means are readily available for prepayment customers to purchase service credits on a 24-hour-a-day, seven-day-a-week basis
- Prepayment customers can return to credit-based service at no higher cost than the cost at which new customers can obtain service
- Payments to prepaid accounts are promptly posted to a customer's account to prevent disconnection or other action adverse to the customer under circumstances in which the customer has in fact made payment
- Adequate financial mechanisms are developed and in place within the state to guarantee that funds prepaid by customers are returned to the customers who prepaid them when a company becomes insolvent, goes out of business, or is otherwise unable to provide the services for which the funds were prepaid

Some of the consumer protection policies have been successfully demonstrated by other countries (Esteves et al. 2016). In some countries, such as Bangladesh and Ireland, utilities are required by law to give prepay customers a 2% discount on their electricity rates. In Colombia, the utility may ask for part of prepay top-up credits to go toward paying outstanding arrearages, but this may only be a maximum of 10% of their top-up (some US programs are allowed to require up to 40% to be debt repayment). However those Columbian utilities can also force consumers to switch to prepay if they fail to pay their electricity bill for two cycles.

Appendix E: Detailed Assessment of Evaluations

Program: Arizona Public Service, Arizona

Reference: Demand Side Management Residential Prepaid Energy Conservation Pilot Program: End of Pilot Report; Authors or organizations: Arizona Public Service (APS); Date: February 13, 2015; Source: APS

Quality: Acceptable. The methodology and duration were reasonable, and the report was transparent. However the final analysis was conducted on a small sample, and the number of months that customers were followed was not clear. The evaluation is commended for excluding customer disconnections from savings estimates and providing a detailed analysis of customer disconnections. This is also the only evaluation we found that included a cost-benefit analysis.

Program duration at time of evaluation: Some months before prepay, ~12–16 months with prepay

Electricity savings: 7.5%

Calculation of savings controls for disconnects: Yes

Costs, compared to postpay: Higher. This is because of third-party vendor fees (at kiosk and for online credit card). No reconnection fees, access fees. kWh rates are the same.

Notes: Difference-in-difference regression analysis was conducted with 86 pairs (out of 610 with pre-post data). After controlling for disconnects, found 7.5% savings. Without controlling for disconnects, the authors found 7.6% savings. Savings was driven by low-income consumers, but this may have been partly due to lack of a sufficient number of mid- and high-income participants to find a reliable result.

Number of participants: 86 in each group (prepay and control)

Evaluation design: Pre-post and matched control (difference-in-difference analysis)

Year of publication: 2015

Program: Direct Energy, Texas

Reference: Eryilmaz, D., and S. Gafford. 2018. "Can a Daily Electricity Bill Unlock Energy Efficiency? Evidence from Texas." *The Electricity Journal* 31 (3): 7–11. www.sciencedirect.com/science/article/pii/S1040619018300666.

Quality: Acceptable. The results are published in a peer-reviewed journal, but the method by which the control group was selected is questionable. A nonmatched control group may create a selection bias that was not adequately controlled using their statistical approach. The sample size and relative costs of prepay compared to non-prepay are not transparent. They are commended for excluding savings from customer disconnections.

Program duration at time of evaluation: Three years with prepay

Electricity savings: 9.6%

Calculation of savings controls for disconnects: Yes

Costs, compared to postpay: Similar. No deposit. No transaction fees. No late fees. No reconnection fees. No debt repayment requirement. Possibly slightly higher average kWh rates than postpay.

Notes: The program had a slightly different type of approach to prepay than other programs. Customers received daily bills reflecting their usage from two days prior, and this bill was automatically deducted from preloaded credit. Customers received the bill at 8 AM and were shut off at 10 AM if they had insufficient credit. Some customers qualified for low-income electricity subsidies. Nonsubsidized electricity customers saved more electricity than subsidized customers (0.92%–6.79% versus 9.58%–13.21%).

Number of participants: Unclear. The authors stated that they had "over 20,000 customer years" in each study group. However the exact number is not disclosed. One would estimate an average of approximately 6,700 customers each year (given the three-year duration), but the exact number included in the final analysis is not presented.

Evaluation design: Nonmatched control group. Attempted to control for selection bias statistically using the "instrumental variable approach." However the selection of the instrumental variable was not sufficient to rule out potential bias.

Year published: 2018

Program: Duke Energy Carolinas, North and South Carolina

Reference: Duke Energy Carolinas Prepaid Advantage Pilot Earnings Report; Authors or organizations: Duke Energy Carolinas; Date: August 15, 2017; Source: Docket No. 2015-136-E, South Carolina PSC North and South Carolina

Quality: Acceptable. The methodology and duration were reasonable, and the report was transparent. However the final analysis was conducted on a small sample, which could be the reason for the non–statistically significant savings. The evaluation did not exclude customer disconnections from savings estimates.

Program duration at time of evaluation: Two years with prepay

Electricity savings: Not statistically significant

Calculation of savings controls for disconnects: No

Costs, compared to postpay: Higher. This is because of third-party vendor fees (credit card charge if more than two payments/month) and because the first 25% of top-ups goes to debt repayment (leaving less money for customers to purchase electricity). Late fees may apply (not clear). No monthly access fees. kWh rates are the same.

Notes: Due to undescribed data analysis problems, only 74 homes were included in the analysis, and the observed average reduction of 8.6% was not statistically significant.

Number of participants: 74 in each group (prepay and control)

Evaluation design: Matched control group (post analysis only)

Year published: 2017

Program: Eskom, Cape Town, South Africa

Reference: Jack, B. K., and G. Smith. 2016. Charging Ahead: Prepaid Electricity Metering in South Africa (No. w22895). National Bureau of Economic Research. http://www.nber.org/papers/w22895.

Quality: Acceptable. The evaluation included all relevant information, used a large sample size, and was of sufficient study duration. The evaluation studied only customers who were enrolled in prepay involuntarily and therefore eliminated self-selection bias. It also observed 27 separate groups of prepay transitions (from prepay to postpay) to determine results. It did not include a control group, but these other elements nevertheless creatively compensated some of the bias created by using a nonexperimental method.

Program duration at time of evaluation: ~16 months with prepay (plus ~38 months before prepay)

Electricity savings: 13%

Calculation of savings controls for disconnects: No

Costs, compared to postpay: Possibly slightly higher for some. Rates and fees were the same, but customers who were on “lifeline tariff” before prepay were moved to the more expensive "domestic tariff" after switching to prepay. This lasted an average of three months (sometimes permanently). No third-party vendor fees or kiosk fees.

Notes: The program targeted regions with low property values and therefore cannot be generalized outside these areas of South Africa. Authors observed the largest reductions in energy use for high-baseline energy consumers and those with frequently delinquent payments.

Number of participants: 4,246 (no control group)

Evaluation design: Compared usage for 27 groups of customers before and after prepay (pre-post)

Year published: 2016

Program: Glacier Electric Cooperative, Montana; Pacific Northwest PenLight, Washington

Reference: Prepay Energy Conservation Impact Study; Prepared by DEFG for the Northwest Energy Efficiency Alliance, 2014.

Quality: Acceptable or limited. The methodology was reasonable although the studies lacked control groups and were somewhat short. The PenLight subgroup was small and used only a pre-post comparison. The report also lacked detail on relative costs and convenience of prepay compared to postpay plans. However evaluations are commended for excluding customer disconnections from savings estimates and for surveying customers regarding their actual behavior change. This is the only American study to do so.

Program duration at time of evaluation: Glacier ~9 months (including some months before prepay and some with prepay); PenLight ~13 months (including some months before prepay and some with prepay)

Electricity savings: 14%; 5.5%

Calculation of savings controls for disconnects: Yes, but the procedure is debated. The Glacier Electric evaluation attempted to account for disconnections in the regression analysis but may do so in a less-than-optimal way. The authors include separate variables for disconnections and prepaid metering, plus an interaction of the two. They interpret the effect of prepaid only to be independent of the effect of disconnections on consumption because the regression also includes disconnections. However prepaid metering also has a causal effect on disconnections. If the disconnection variable were categorical, then the approach could generate an interpretation that the prepaid coefficient is the effect of prepaid metering among the group of customers with zero disconnections. However the groups differ by meter type and therefore prepaid metering affects disconnections. This means that the interpretation may be suboptimal (K. Jack, Assistant Professor of Economics, Tufts University, pers. comm., August 14, 2018). The authors also disclose that allowing electricity to be disconnected was a strong potential factor for reducing electricity in the prepay group.

Costs, compared to postpay: Not available in either case

Notes: Surveys revealed that customers engaged in a number of behaviors to reduce their electricity use. The behaviors that appeared to have the most impact were upgrading or changing the thermostat and allowing the electricity to be remotely shut off. They also found that customers on prepay who used more electricity were disconnected more frequently (the opposite of what occurs for postpay customers).

Number of participants: Glacier 1,240; PenLight 154

Evaluation design: Pre-post (no control group)

Year: 2014

Program: Oklahoma Electric Cooperative, Oklahoma

Reference: The Effect of Prepayment on Energy Use; By Michael Ozog, PhD, Integral Analytics. A research Project Commissioned by DEFG Prepay Energy Working group. March 2013. defgllc.com/publication/the-effect-of-prepayment-on-energy-use/.

Quality: Acceptable. The methodology, sample size, and duration were reasonable, and the report was transparent. The evaluation is commended for excluding customer disconnections from savings estimates. The evaluation is one of few that investigated the duration of customer disconnections. However the study did not include a control group, and some cost information was difficult to find.

Program duration at time of evaluation: ~32 months before prepay, ~22 months with prepay

Electricity savings: 10.4%

Calculation of savings controls for disconnects: Yes, but the procedure is debated. See Glacier and PenLight evaluations for details.

Costs, compared to postpay: Higher. Possible monthly vendor fee. Possibly higher rates during pilot program. Some third-party vendor fees (charge for check or credit card). No late fees. Debt repayment is optional.

Notes: When consumer disconnects are not controlled for, savings is 11%. Ninety-one percent of customer disconnections lasted no more than one day. Of those, one-third (32%) lasted one hour. However 4% of disconnects lasted over three days.

Number of participants: 1,217

Evaluation design: Pre-post (no control group)

Year: 2013

Program: Salt River Project M-Power program 2008–2009, Arizona

Reference: Qiu, Y, B. Xing, and Y. D. Wang. 2016. "Prepaid Electricity Plan and Electricity Consumption Behavior." *Contemporary Economic Policy* 35 (1): 125–142.

Quality: Acceptable. The evaluation included all relevant information, used a large sample size, and was of sufficient study duration. The evaluation was transparent and clearly explained the matching procedure for control participants. It used a pre-post evaluation in combination with a matched control group. The study clearly laid out sufficient detail to allow readers to understand the limitations of the study (that the prepay group paid higher costs and had less-convenient payment options). The study was published in a peer-reviewed journal.

Program duration at time of evaluation: One year before prepay, one year with prepay

Electricity savings: 12%

Calculation of savings controls for disconnects: No

Costs, compared to postpay: Higher. This is because the first 35% to 40% of top-up payments went to debt repayment (as determined from other sources) and because other rates and fees were higher. Thus customers would have fewer funds to purchase electricity credits. Costs include a one-time service establishment fee, a deposit for the prepay meter, reconnection fees, and higher rates than postpay.

Notes: The biggest savers were those with lowest income and most arrearages. Savings were higher in the summer. Payment required an in-person trip to a payment kiosk. Trips were made an average of three to four times per month. The increased effort required for making multiple trips per month to the kiosk could have partly explained the savings from this program.

Number of participants: 1,641 in each group (prepay and control)

Evaluation design: Pre-post and matched control (difference-in-difference analysis)

Year: 2016

Program: Kentucky Association of Electric Cooperatives, Kentucky

Reference: Martin, W. M. 2014. "Pay-as-You-Go Electricity: The Impact of Prepay Programs on Electricity Consumption" (master's thesis, University of Kentucky). william.martin24@uky.edu; uknowledge.uky.edu/do/search/?q=William%20Martin%20&start=0&context=1737482&facet=publication_year%3A2014#.

Quality: Acceptable. The evaluation included all relevant information, used a reasonable sample size, and was of sufficient study duration. The evaluation was transparent and clearly explained the details of the prepay and postpay plans, allowing readers to understand the limitations of the study (that the prepay group paid higher costs). However the author did not attempt a difference-in-difference analysis because he had access to only a nonmatched comparison group and did not include details of payment options (i.e., convenience) for both groups. The author also did not calculate savings separately for each utility and did not enumerate all the costs to customers. The study was conducted as part of a master's thesis and, as such, underwent some degree of peer review.

Program duration at time of evaluation: ~One year prepay (and up to three years before prepay)

Electricity savings: 11.1%

Calculation of savings controls for disconnects: No

Costs, compared to postpay: Higher. This is because of monthly vendor fee and transaction fees for one of the two utilities. Third-party vendor fees and debt repayment requirement were possible. kWh rates were similar to postpay and no late fees.

Notes: The savings were calculated as a pooled analysis of two electric co-ops (Bluegrass and Jackson). More savings were found during hot or cold days than mild days. Consumers saved less over time in the program.

Number of participants: 574

Evaluation design: Pre-post (no control group)

Year: 2014

Program: Salt River Project 2003–2006, Arizona

Reference: Paying Upfront: A Review of Salt River Project's M-Power Prepaid Program; Authors or organizations: EPRI; Date: October 2010; Source: EPRI

Quality: Limited. The evaluation was not conducted by a third-party evaluator, and the report lacked sufficient detail to assess its quality. The report discusses three studies: one covering 2002–03 program year, one for 2003–04, and one for 2005–06. Details are available only for the 2005–06 study, in which they found 12% savings. In the first two years, the report cites average savings of 11% and 13%, respectively (but provides no details for control group or matching criteria).

Program duration at time of evaluation: One year before prepay, one year with prepay for 2005–06 section of evaluation

Electricity savings: 12%

Calculation of savings controls for disconnects: No

Costs, compared to postpay: Higher. This is because the first 40% of top-up payments went to debt repayment (as mentioned in the report) and because other rates and fees were higher. Thus customers were left with fewer funds with which to purchase electricity. Costs include a one-time service establishment fee, a deposit for the prepay meter, reconnection fees, and higher rates than postpay.

Notes: The 12% savings comprises an 8% reduction by participants and a 4% increase by the comparison group. Payment required an in-person trip to a payment kiosk. Trips were made an average of three to four times per month. The increased effort required for making multiple trips per month to the kiosk could have partly explained the savings from this program.

Number of participants: 463 in each group (prepay and control)

Evaluation design: Pre-post and matched control (difference-in-difference analysis)

Year: 2010

Program: TVA utilities, Tennessee

Reference: Prepaid Metering Program Study in the Tennessee Valley: Measuring the Change in Energy Consumption (PowerPoint presentation); Authors or organizations: DNV GL; Date: 2016; Source: Unknown

Quality: Limited. The information for these six utility prepay programs comes from a summary provided in a PowerPoint presentation. Although the evaluation was conducted by a third-party evaluator, the report was not made public, and thus detail was insufficient to assess the quality of the evaluation. The utility names were made anonymous in the report. The evaluation periods were short, and in some cases, the programs had small sample sizes. Although matched control groups were included, the size of these groups and criteria for matching are unknown. Whether evaluators excluded savings from disconnections in their savings estimates is not indicated.

Program duration at time of evaluation: ~One year with prepay

Electricity savings: 5.6%; 6.7%; 5%; 6.9%; 11.7%; 6.8%

Calculation of savings controls for disconnects: No

Costs, compared to postpay: Unclear. The PowerPoint presentation has insufficient detail. A monthly access charge appears to be required. The utilities may have charged third-party vendor fees (e.g., at kiosk) or reconnection fees. However the kWh rates are the same.

Notes: For most programs, savings were higher in the winter and for high-baseline electricity customers. One program found savings to be slightly higher in low-baseline electricity customers. The authors note that the one program that had significantly higher savings than the others (11.7%) is an aberration and that they expected savings to decrease as the program matures.

Number of participants: 350 prepay customers; 184 prepay customers; 201 prepay customers; 183 prepay customers; 145 prepay customers; 76 prepay customers

Evaluation design: Matched control group

Year: 2016