Energy savings at Good Burger using technology, data, and behavioral change

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Better Buildings Case Competition

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Executive Summary

Good Burger, a fast-food restaurant chain, has implemented an energy savings initiative to achieve a 10% reduction below 2004 levels by 2020 within corporate-owned stores and would like to implement a similar initiative across its franchises.

Replacing equipment in restaurants with Energy Star certified appliances can save an estimated 23% to 33% of energy usage. Energy Star equipment typically carries a cost premium of 15% over traditional equipment. In addition, active behavioral change initiatives with respect to energy consumption have been found to save approximately 10 to 15%. Recent advances in the field of machine learning have led to several companies that can disaggregate consumption by appliance and identify best practices to save energy. This service, called non-intrusive load monitoring, requires little capital investment and is available from several existing companies specifically for the restaurant industry.

To achieve the 10% energy savings goal for franchise stores, we recommend that Good Burger create a company-wide energy reduction competition. Stores that participate will receive load monitoring equipment and disaggregation service from a third party company. They will also receive manager training and risk-neutral financing options for Energy Star appliances. Under this program, each participating store will pay a fixed fee—recoverable via decreased energy costs—to Good Burger corporate for all services and training. The fee is designed to cover all costs to corporate and to capture some of the economic benefits realized from energy savings at each store. To incentivize participation, corporate will provide a financial reward to the winner as well as regular updates on each store's progress.

Our recommendation assumes:

- $2,000 per store for the energy sensing and communication equipment,
- $100 per month per store for the energy monitoring and feedback service,
- $240 per store for a ½ day training session,
- A conservative 19% energy savings for replacing all equipment over the next 6 years,
- A conservative 10% energy savings from behavioral changes,
- An initial $5,000 annual marketing cost that decreases over time,
- An initial pilot cost of $5,000,
- An annual $5,000 reward to the winning franchise.

The energy and financial models of our recommendation demonstrate expected achievement of the 10% energy savings goal with a 50% franchise participation rate. At this level of participation, corporate realizes $900,000 in Net Present Value (NPV) terms over six years. With only 3% participation, corporate recovers all costs. We estimate that NPV to participating stores is $26,000 to $32,000 over the next 10 years—a "win" for both corporate headquarters and franchisees.

Additional recommendations for future consideration to improve operations, profitability, and customer service to all Good Burger stores include: (1) capacitor installation to reduce reactive power consumption, (2) robotic systems with machine learning algorithms to predict customer orders, and (3) online ordering to improve food preparation efficiency and food quality.

1 Overview

Reducing energy consumption can improve business profitability as well as reduce environmental impacts. All stakeholders of the Good Burger restaurant chain (from here on referred to as Good Burger) would benefit from more aggressive reductions in energy consumption. This report outlines our proposal to Good Burger for an updated energy efficiency program that achieves a 10% reduction in energy consumption across all stores by 2020. Our proposal improves *profit*, *product quality*, and *brand name* to both franchise stores and the Good Burger Corporation.

In 2005, Good Burger established a goal of achieving 10% energy reduction below 2004 baselines by 2020 in corporate-owned locations. However, this program does not apply to the 7,200 stores—90% of Good Burger locations—that are franchised. Feasible methods to achieve energy savings at these franchised locations are heavily constrained by the economics of the industry. Energy consumption accounts for only 3-4% of overall costs at stores and profit margins are thin, leaving little room for investments (BBCC, 2014). Furthermore, there is a disconnect between corporate and franchisee incentives regarding energy efficiency goals. Stores don't have large budgets to invest and corporate revenue is tied only to sales, independent of a store's energy use. Existing franchise agreements also limit corporate's ability to mandate certain conditions, such as energy efficiency goals. Therefore, a new program is necessary to ensure that Good Burger reaches the 10% reduction goal across all stores.

There are two main strategies that can reduce a restaurant's energy consumption: (1) replacing the existing equipment (i.e., kitchen appliance, HVAC, lighting, etc.) with more energy efficient ones (e.g., Energy Star certified equipment, properly sized HVAC, etc.), and (2) improving existing practices and energy-related behavior. The next section of this report describes these options and their associated economics. Section 3 outlines our recommendation, Section 4 presents our financial model and assumptions, Section 5 shows results from our analysis, and Section 6 provides additional recommendations to Good Burger regarding energy efficiency.

2 Methods for reducing energy costs at restaurants

2.1 Equipment upgrades

In 2012, the Environmental Protection Agency (EPA) published a report highlighting the economic savings to the restaurant industry, through reduced energy costs, as a result of investing in Energy Star certified appliances (Energy Star, 2012). **Error! Reference source not found.** summarizes these findings as well as estimated energy savings (MMBTU), based on average U.S. electricity and natural gas prices.

The EPA also published a spreadsheet for calculating energy savings resulting from equipment replacement practices (Energy Star, 2014). Using this spreadsheet, energy savings due to new Energy Star appliances are estimated to be between 23% and 33%, depending on whether the equipment is fueled by natural gas or electricity. To be conservative, in our analysis, we use the lower estimates from **Error! Reference source not found.** (i.e., **19%**).

Based on these estimates, as a result of replacing all equipment listed in Table 1, a Good Burger store can save about **390 MMBTU**. This would reduce a store's energy consumption by about

19%; the average consumption of Good Burger stores is about 2,060 MMBTU per year (BBCC, 2014).

This suggests that in order for stores to achieve a 10% reduction in energy consumption by 2020, **about half the equipment** in each store must be replaced. However, these estimates do not consider that stores may have already replaced some/all of their equipment. Kitchen equipment lifetime ranges from 7 to 10 years and 15 years for HAVC systems, beyond the timeline of the energy goal.

The Internal Revenue Service (IRS) depreciation guidelines generally specify a 5-year recovery period for this type of equipment; therefore replacing equipment earlier than necessary can be beneficial in lowering taxable income. Furthermore, there are government incentives, on the order of $0.60 to $1.80 per square foot, to upgrade to energy efficient equipment. These tax benefits and incentives may incentivize stores to replace equipment before the end of their effective lifetimes.

Table 1: Estimated economic and energy savings from restaurant equipment replacement from Energy Star Guide for Restaurants (Energy Star, 2010)

Item	Improved Efficiency % [1]	Lifetime[3] (yr)	Savings by energy type ($) ELE	GAS	WATER	Total savings $	MMBTU[2]
Steamer	60%	12	$1,100	-	$1,000	$2,100	37
Holding cabinet	65%	10	$650	-	-	$650	22
Fryer	30%	10	-	$470	-	$470	58
Oven	10-25%	10	-	$360	-	$360	44
Griddle	10-25%	10	-	$175	-	$175	22
Freezer (reach in)	30%	9	$175	-		$175	6
Ice Machine	15%	7	$130	-	$18	$148	4
Refrigerators (reach in)	30%	10	$55	-		$55	2
HVAC	15%[3]	15	$4,800	-		$4,800	162
Dishwasher	25%	10	$720	-	$300	$1,020	24
Bulbs (assumes 10)	75%[2]	10	$330	-		$330	11
Subtotal			**$7,960**	**$1,005**	**$1,318**	**$10,300**	**392**
Average Good Burger store Saving						**$26,000[4]**	**2060[5]**
Change%						**40%**	**19%**

1) Energy Star Benefits (2014)
2) Calculated based on average U.S. commercial electricity and gas price in 2012 (EIA, 2014a, EIA, 2014b)
3) Katsigris & Thomas (2008)
4) Assuming total sales of $750,000, a 10% profit margin, and 3% energy cost based on total costs (BBCC, 2014)
5) Assuming 686 kBTU/sf/yr and 3,000 square feet per store (BBCC, 2014)

Despite these benefits, *capital costs* can be a barrier to replacing equipment. We estimate that replacing all items in Table 1 with conventional technology table would cost about **$65,000**[1]. Many stores simply don't have the budget to make these investments. Further, Energy Star equipment often costs more than conventional technologies, **up to 15%** for some appliances (Energy Star, 2014), which increases total costs to about **$75,000**. A simple solution for this would be for Good Burger Corporation to help stores by purchasing Energy Star certified equipment in bulk and arranging payment plans to stores. For example, several Energy Star

[1] Based on several reports and online sources (See Appendix A)

freezers, each costing $4,000 individually, could be purchased at a large discount by corporate, e.g., around 20%, and then financed to franchisees with a suitable interest rate. For example, at 8% interest for 5 years, a store would pay $800/year, or $4,000 total, the same price before the discount. These arrangements would help stores purchase Energy Star certified equipment with little risk to corporate.

2.2 Energy efficiency through best practices

In the same report (Energy Star, 2012), the EPA also estimated energy savings as the result of implementing improved practices and energy-related behavior in restaurants. These savings are reported in Table 2 for various equipment types. Here, we excluded recommendations that require stores to be closed, since many Good Burger stores are moving towards 24-hour operation (BBCC, 2014).

Many of the suggested improvements result from turning off idle equipment and better optimizing usage throughout the day. Implementing all measures would result in savings of about **213 MMBTU**, or about **10%** of average store consumption.

Although operational improvements can yield substantial savings, their implementation can be challenging. Employees and managers need to know **when**, **where**, and **how much** energy waste occurs throughout their store, as well as **the reasons** for such wastes. Even trained professionals need proper measurements and data to identify efficiency solutions. As a result, several innovative firms have emerged over the past few years to provide this detail to homeowners and businesses.

Table 2: Estimated economic and energy savings from restaurant best practices suggested by Energy Star Guide for Restaurants (Energy Star, 2010)

Item	Behavioral Change	Savings by energy type ($)			Total	
		ELE	GAS	WATER	$	MMBTU[1]
Steamer	reduce idle (1 hr)	$250	-	-	$250	8
Fryer	reduce idle (4 hr)	-	$400	-	$400	49
Combined oven	reduce idle (2 hr)	$400	-	-	$400	14
Griddle	reduce idle (3 hr)		$250	-	$250	31
Broiler	reduce idle (3 hr)		900	-	$900	111
Pipes/sinks	fix leaks		-	$1,000	$1,000	0
Subtotal		**$650**	**$1,550**	**$1,000**	**$3,200**	**213**
Average Good Burger store					**$26,000[2]**	**2060[3]**
% Change					**12%**	**10%**

1) Calculated based on average U.S. commercial electricity and gas price in 2012 (EIA, 2014a, EIA, 2014b)
2) Assuming total sales of $750,000, a 10% profit margin, and 3% energy cost based on total costs (BBCC, 2014)
3) Assuming 686 kBTU/sf/yr and 3,000 square feet per store (BBCC, 2014)

2.3 Technology solutions to improve behavior

Recent research on human behavior regarding energy use suggests that many people lack understanding of how appliances actually consume energy (Attari et al. 2010; Frederick et al. 2011). Even when energy consumers are motivated to reduce energy consumption, their misperceptions often lead to suboptimal efforts. One of the first steps in changing behavior is making sure all participants are properly trained and knowledgeable about the equipment they are using.

Monthly energy bills provide little information to business owners about the efficiency of their consumption behavior, possible sources of waste, and potential reasons and corresponding solutions. A detailed breakdown of energy consumption is needed (Abrahamse et al., 2007). A consumption/cost breakdown for every energy end-use, similar to an itemized shopping receipt, would help business managers identify wasted energy.

Traditionally, sub-metering of all appliances is required to obtain such consumption/cost breakdown for every energy end-use. However, sub-metering is not only costly and time consuming; it is also associated with large maintenance and technical difficulties, making business owners reluctant to take on such practices. Recent advances in data analysis techniques in the field of Machine Learning can be used to disaggregate energy consumption data into different end-uses. Non-intrusive load monitoring (NILM) refers to data-driven techniques for measuring consumption of appliances without the need for sub-metering. Sophisticated machine learning algorithms help estimate the nature of individual loads, their consumption, and utilization statistics (Hart, 1992).

NILM has been actively researched over the past three decades, and currently, several companies around the world apply NILM to provide disaggregated feedback on appliances and consumption behavior. In the U.S., companies such as Plotwatt, Bidgely, LoadIQ, Verdigris, and Verlitics have developed useful applications that disaggregate electricity consumption data to identify best practices for reducing energy costs at both residential and commercial scales. Parson (Parson, 2012), summarizes a list of companies throughout the world that apply NILM for helping household and business owners to achieve energy efficiency with no need for sub-metering.

Studies reveal significant energy savings as the result of disaggregated feedback. Ehrhardt-Martinez el al. (2010) conducted a literature review of different studies on disaggregated feedback. These studies suggest that **10 to 15%** energy savings can be achieved by using disaggregated feedback to change consumption behavior, proactively maintain appliances, and install new devices (Dobson and Griffin 1992; Ueno et al. 2006; Wood & Newborough 2003; Karbo & Larsen 2005).

To understand the type of services that these companies can provide, we interviewed an expert from a company called PlotWatt. We targeted PlotWatt because of their successful experience in providing disaggregation services in restaurant chains such as Dunkin' Donuts, Wendy's, and McDonald's. In addition to disaggregating load data, PlotWatt provides *daily* reports to restaurant managers about the consumption of different appliances, wasteful behaviors, and even proactive maintenance alarms (Interview with PlotWatt, 2014).

Box 1 illustrates examples of services PlotWatt provides in terms of identifying wasteful appliance/behavior mentioned by the interviewee.

Box 1: PlotWatt Testimonials

> *"Filtering oil in a fryer consumes a lot of energy. [Restaurants] usually filter the oil in the evening, say around 8:00pm. We found that on some days, employees would turn the filter on again the next morning, which was unnecessary! It was a result of poor communication."*

> *"Managers at Dunkin' Donuts thought that the large ovens were the largest consumers of energy in their restaurant. This turned out to be true. However, in addition to the oven, toasters were also large consumers of energy. Simple changes to employee practices saved them energy. You don't know what you don't know!"*

Figure 1 shows an example of how NILM helps restaurants improve their energy efficiency. A sensor installed at the store collects data on energy consumption. This data is automatically sent via web to the company providing the data disaggregation service. The company then runs algorithms to disaggregate load, analyzes the results, and provides specific recommendations based on the analysis. This information is sent back to the restaurant in regular reports.

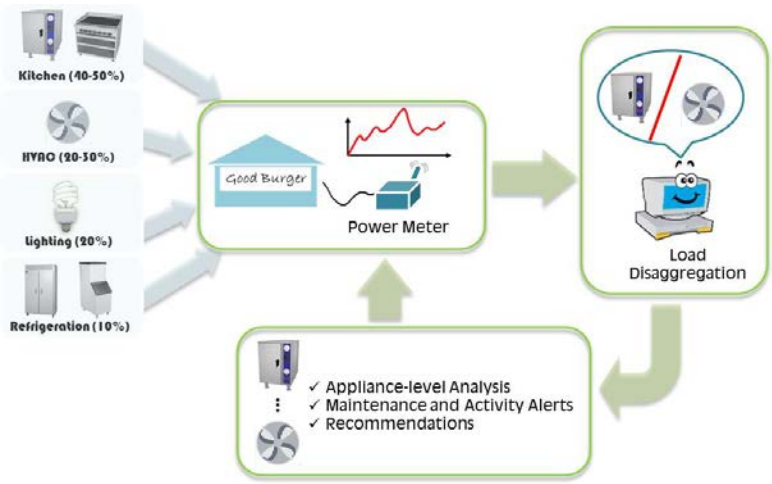

Figure 1: Proposed disaggregated feedback system

3 Recommendation: company-wide energy efficiency competition

We recommend that Good Burger Corporation encourage franchise stores to *install new equipment* and/or *adopt best practices* as suggested by Energy Star (summarized in **Error! Reference source not found.** and **Error! Reference source not found.**). We also recommend that stores use *disaggregated load feedback* to facilitate *identification* and *application* of best practices. These measures may take place without corporate initiative, but to ensure that the 10% company-wide goal is met, an effective energy efficiency program is needed.

Any measure to effectively improve energy efficiency must consider human motivation (Clayton & Meyers 2009, McCalley & Midden 2002). To incentivize stores and their employees to make these changes, we recommend that corporate establishes **a voluntary competition** among franchise stores for reducing energy consumption. Figure 2 illustrates how firms will participate and be evaluated during the competition. Below are our recommendations for how to organize the competition.

Duration: Each year, the goal of the competition is for each participating store to maximize the percent reduction in annual energy consumption below a starting baseline, calibrated to their historical consumption. The store with the highest annual percent reduction wins. We recommend that the competition continue each year until 2020 to ensure that the 10% reduction

goal is met. Reward criteria may be adjusted to reward stores for maintaining gains achieved in previous years.

Store participation: The competition is designed specifically for franchise stores. We assume that in absence of the competition, corporate-owned stores have already or will reach the 10% energy consumption reduction target set in 2005 (BBCC, 2014). However, all stores can voluntarily participate in the competition.

Accountability and reduction options:

Improving current practices: Stores that participate will be required to add load disaggregation technology and services provided by a third-party company (examples of the companies are given in Section 2.3). Once the equipment is installed, corporate (or third-party company) will assess the progress of each participating store, and provide updates to all participants on a monthly bases.

Corporate will also provide half-day training to a manager at each store to ensure adequate instruction on energy efficiency best practices as well as the terms of the competition. Managers of each store are assumed to transfer the necessary instructions, information and insights about the process to their employees.

New equipment: Corporate will provide risk-neutral financing for purchasing Energy Star appliances to stores that choose to replace their equipment. Financing terms can be negotiated per store.

Corporate and store agreement: All stores that enter the competition pay an upfront fee to corporate in exchange for the monitoring equipment, consulting service, and manager training. This fee is designed to cover all costs to corporate, and, based on our analyses, ranges from $1,000 to $3,000 depending on the annualized cost of the monitoring equipment and consulting service.

Reward: At the end of each year, the store with the largest percent reduction in energy consumption will receive a financial award. The reward can be spent by the store manager at their discretion. However, all employees involved in the energy reduction efforts must receive equal compensation from the reward, estimated by hours worked during the competition period. All stores that participate will receive a plaque (silver), honoring their involvement in energy efficiency efforts. The winner will receive a plaque with special distinction (gold).

Behavioral Change: All stores that participate will receive regular reports from corporate (or third party) that shows how they are performing compared to all other stores. Studies have shown that relative feedback has enormous impacts on energy efficiency behavior (Siero et al. 1996), especially when the feedback comes from energy efficiency products and services (McCalley & Midden 2002).

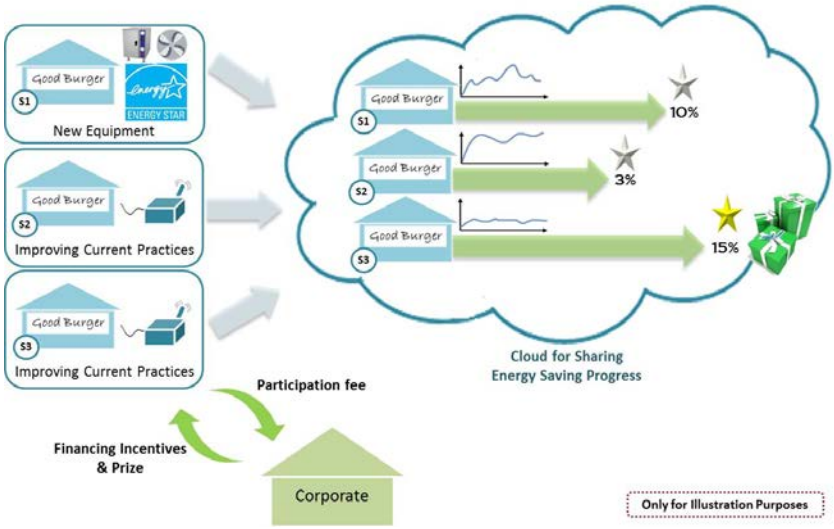

Figure 2: Schematic overview of the enter-store competition for energy saving

4 Financial model

We built a financial model to estimate the energy savings and associated economic benefits of the proposed competition. Table 3 summarizes the cash flow to corporate for organizing the competition assuming **50% participation** (i.e., 3,600 of franchise stores) as an example.

Table 3: Cash flow to corporate with 50% of franchisees participating starting in 2015

Year	2014	2015	2016	2017	2018	2019	2020
Program costs							
Marketing & Admin	$5,000	$4,500	$4,050	$3,650	$3,280	$2,950	$2,660
Initial pilot	$5,000						
Reward		$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Cost per store							
Annualized equipment/ service cost		$1,480	$1,480	$1,480	$1,480	$1,480	$1,480
Training cost		$240	$240	$240	$240	$240	$240
Revenue per store							
Fee to participate		$1,770	$1,770	$1,770	$1,770	$1,770	$1,770
Cash flow	($10,000)	$169,000	$170,000	$170,000	$170,000	$171,000	$171,000

Based on two reports published in Harvard Business Review (Leslie & Holloway, 2006) and The Economist (The Economist, 2009), in the first year, we assume that corporate incurs **marketing costs of $5,000 decreasing by 10% per year**. We also assume an **initial pilot cost of $5,000**, which we estimate is the cost to test the program in 10 stores in the first year. Lastly, we assume that the reward for the competition each year is $5,000.

There are also costs incurred by corporate for each store in the competition. Each participating store requires sensor and communication equipment as well as the load disaggregation service provided by a third-party. We assume that these services can provide monitoring, analysis, and

recommendations based on both electricity and natural gas consumption. To estimate these costs, we rely on the metering cost suggestions given by the "Metering Best Practices guideline" produced by the Department of Energy for federal facilities (DOE, 2011). **Error! Reference source not found.** Table 4 summarizes the costs per meter, which includes the sensor itself, associated communication equipment, software, and installation. Based on **Error! Reference source not found.**, in our analysis, we assume costs of **$2,000 for the sensing and communication equipment**, annualized over a lifetime of 10 years (DOE, 2011). For service costs, we assume that the third party will add a profit margin to the monthly service fee. We therefore assume that the monthly fee is $100 per month, twice the "high" monthly costs reported by DOE (2011).

Table 4: Metering Cost reported by Metering Best Practices guide (DoE, 2011)

	Low	Average	High
Metering cost ($/meter)	$1,500	$2,000	$2,500
On-going monthly cost ($/meter/month)	$10	-	$50

To annualize costs, we assume a **discount rate of 6.2%**, equal to the industry's weighted average cost of capital (WACC) from Yahoo finance (Yahoo Finance, 2014). We also assume that each store receives **training for a half-day**, involving two managers and totaling 8 hours, and that each manager has a wage of $30 per hour. The fee collected by corporate is assumed to be equal to the annualized cost of the equipment and load disaggregation service plus a **20% premium** to account for all other capital costs.

Stores that participate in the competition benefit from reduced energy costs per year. We calculate these reductions by assuming a **50% phase in** of the reductions suggested by Energy Star for best practices in **Error! Reference source not found.**, **increasing by 10%** each year after.

According to BBCC (2014), energy costs are 3.5% of total costs to each store and stores receive $750,000 in average sales per year (BBCC, 2014). Assuming a **margin of 10%**, energy costs are estimated to be about **$25,000 per store each year as a baseline**. Also, based on BBCC (2014) assumptions, energy consumption is 686 kBTU/sf/yr, with 3,000 square feet per store (BBCC, 2014). Therefore, energy consumption is estimated to be **2060 MMBTU per year**. We also assume that **energy costs increase by 2% each year**, equivalent to Energy Information Administration forecasts in 2014 (EIA 2014c).

In addition to optimizing operations of the store, we assume that all participating stores that replace equipment during this period use **Energy Star** certified appliances with lifetime and energy savings reported in **Error! Reference source not found.**, and incremental cost reported in Appendix A. To be conservative, we assume that stores only replace equipment at the *end of machine lifetimes* and that *baseline lifetime* of equipment in each store is **uniformly distributed between 1 and the estimated lifetime of each machine as listed in** Error! Reference source not found..

We ran **Monte-Carlo simulations** to arrive at total savings and incremental costs per store as a result of adding new Energy Star equipment. To be conservative, **we do not include the expected value of the competition reward** to the store in our cash flow model. Table 5**Error! Reference source not found.** summarizes the cash flow to a participating store.

Table 5: Cash flow to an individual franchise store for participating in the competition (one simulation for the baseline age of existing equipment)

Year	2014	2015	2016	2017	2018	2019	2020
Cost							
Fee to Participate		$1,770	$1,770	$1,770	$1,770	$1,770	$1,770
Energy Star premium[1]		$50	$2,200	$870	$5,200	$1,100	$0
Revenue							
Baseline Energy Costs	$25,000	$25,400	$25,900	$26,500	$27,000	$27,500	$28,100
W/ competition		$22,900	$21,800	$21,100	$18,700	$17,800	$17,500
Total Savings		$2,500	$4,100	$5,400	$8,300	$9,700	$10,600
Cash flow	-	$680	$130	$2,760	$1,330	$6,830	$8,830

1) Incurred when replacing equipment. This result will change with different simulations for the age of existing equipment.

5 Value Proposition

Figure 3 shows the results from100 Monte-Carlo simulations from our financial model described in Section 4. The figure shows the net present value to corporate for hosting the competition as well as a 90% confidence interval of the total energy savings across all stores for a varying number of participating stores. Net present value to **corporate can reach up to $1.9 million** depending on how many stores participate. **For participation above 200 stores (3%), corporate will recover all costs by 2020**. With 400 stores (6%) or more, corporate will recover all costs within 1 year. Corporate therefore has incentive to encourage as many store as possible to enter the competition.

In terms of meeting the energy reduction goal, if **about 50% of franchise stores (3,500)** participate in the competition, Good Burger will **reduce energy consumption by an average of 10% by 2020**. With the same level of participation, corporate will receive **about $900,000 in net present value**.

These estimates assume that not all stores replace equipment within this time period; only when equipment lifetime expires**.** Alternatively, if **all participating stores replace equipment by 2020,** the goal can be met with **only 35% (2,500)** of the franchise stores. If **no stores replace equipment** and instead only change consumption behavior using the disaggregated feedback service, then the 10% reduction goal would be possible if **97% of franchise stores** (i.e., a total of 7,000) participate in the program.

Franchise **stores that participate will receive between $26,000 and $32,000 in net present value over 10 years.** This assumes that stores continue to realize their achieved energy savings beyond 2020. Across all simulations, stores pay off all costs within 1 to 4 years[2].

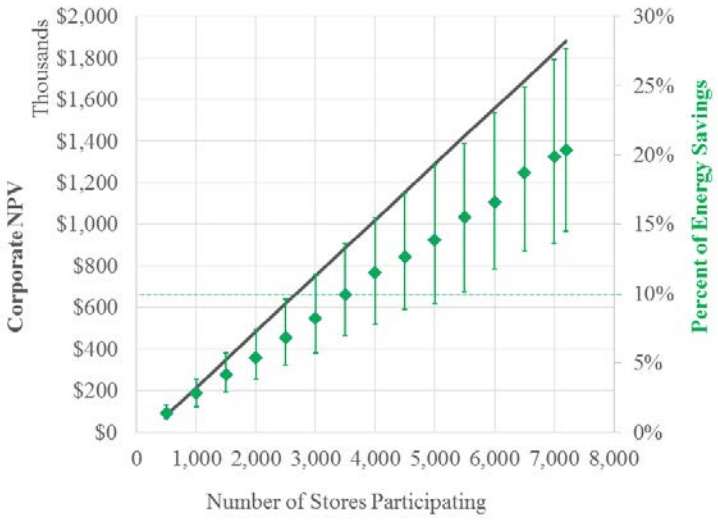

Figure 3: Net present value to corporate (left axis) plotted by the total number of stores participating in the competition. The figure also presents a 90% confidence interval of total energy savings potential (right axis – green). Diamonds represent the mean value from our model simulations.

6 Ancillary Recommendations

In addition to hosting a competition, we provided a list of ancillary recommendations that would improve operations, profitability, and customer service at all Good Burger stores:

Capacitor: Adding capacitors can reduce reactive power consumption by maintaining a constant power factor of 1. A recent study by Schneider Electric shows that capacitors can save up to 1.6% in energy consumption. Further, stores that are in areas in which utilities charge for reactive power consumption can save up to 7% on energy bills (Schneider, 2012). This strategy would cost $1,000 or less per store and, given 7% savings on energy bills, would save about $1,750 per year for a typical Good Burger restaurant.

Robotics: We interviewed a start-up company called Hyperactive Robotics, which uses cameras, historical consumption data, and machine learning algorithms to predict customer preferences before they even enter a fast-food restaurant. With these systems in place, restaurants have increased efficiency in food preparation (thus reducing labor costs), decreased food waste, and increased the quality of food served to customers. These systems also provide specific guidance to managers on how to optimize their operations. If coupled with energy efficiency efforts, these systems could provide substantial financial benefits and energy savings beyond those estimated in this report. Costs for this service are around $200 to $400 per month (Interview with Hyperactive Robotics, 2014).

Online ordering: Based on our interview with an employee of the Chipotle restaurant chain, we found that online ordering can improve efficiency in food preparation and offers a convenient service to customers (Interview with Chipotle, 2014). Online ordering systems also reduce equipment idle time by reducing the number of unexpected orders. This recommendation has little cost and can be sponsored by corporate for all stores.

[2] See Appendix B for a sensitivity analysis on input assumptions.

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Appendix A: Capital costs for appliances

Item	Energy Star Cost ($)	Source	Incr. Cost ($) (Energy Star, 2014)
steamer	7,000	Model: AccuTemp S62083D080 (Energy Star Case Study, 2007)	870
holding cabinet	5,000	Model: Winston HA4522 (Energy Star Case Study, 2007)	0
fryer	7,000	Central restaurant (2014)	1,120
oven	5,800	Central restaurant (2014)	50
griddle	3,000	Central restaurant (2014)	360
freezer - reach in	4,000	Model: True T-49F (Energy Star Case Study, 2007)	0
Ice Machine	2,300	Central restaurant (2014)	0
Refrigerators - reach in	4,000	Model: True T-49 (Energy Star Case Study, 2007)	290
HVAC	22,500	Central restaurant (2014)	4,950
dishwasher	12,000	Central restaurant (2014)	1,710
bulbs (assumes 10)	200	Google Searches	150

Appendix B: Sensitivity analysis

We performed a sensitivity analysis on the financial model by independently varying input parameters by 10% to see the corresponding magnitude change in model outputs (Corporate and Franchise Net Present Values). The results shown in Figure 4demonstrate a robust model and identify key drivers for Good Burger to focus on to ensure the greatest value generation and return on investment.

For Corporate, the key drivers are the equipment and service costs for load disaggregation (of which small changes will be multiplied and magnified by the number of stores participating), the franchise participation rate, the discount rate (WACC), and the store participation fee.

For the franchises, the key drivers are the annual change in energy price, the discount rate, and the equipment and service costs.

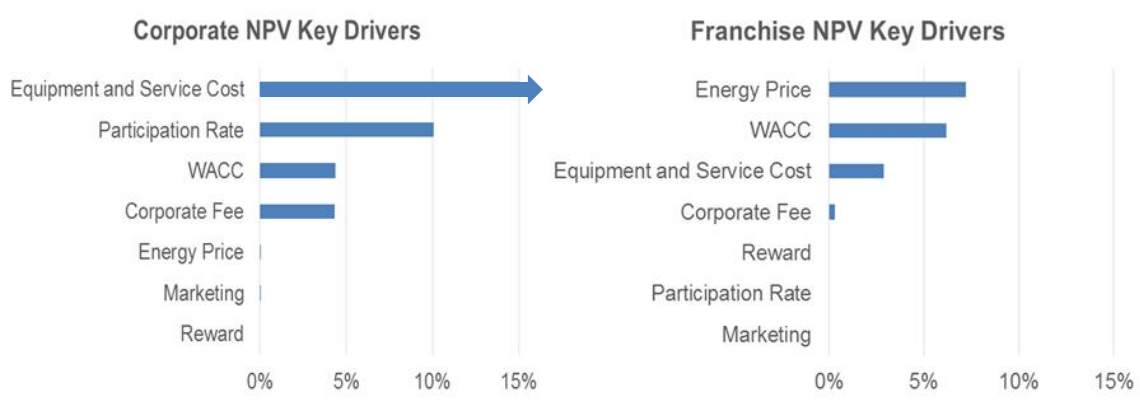

Figure 4: Financial and Energy Model Key Drivers