**Work Paper PGECOFST102**

**Commercial Fryer-Electric and Gas Revision # 6**

**Pacific Gas & Electric Company**

**Customer Energy Solutions**

**Commercial Fryer-Electric and Gas**

Measure Codes F205, F206

# AT-A-Glance Summary — Commercial Fryer

|  |  |  |
| --- | --- | --- |
| **Applicable Measure Codes:** | **F205** | **F206** |
| **Measure Description:** | Commercial Fryer (Electric) | Commercial Fryer (Gas) |
| **Energy Impact Common Units:** | Fryer Vat, each | Fryer Vat, each |
| **Base Case Description:** | Source: PG&E Calculations Existing Electric Fryer | Source: PG&E Calculations Existing Gas Fryer |
| **Base Case Energy Consumption:** | Source: PG&E Calculations 18,079 kWh/yr. | Source: PG&E Calculations 1,657 Therms/ yr. |
| **Measure Energy Consumption:** | Source: PG&E Calculations 15,103 kWh/ yr. | Source: PG&E Calculations 874 Therms/ yr. |
| **Energy Savings (Base Case – Measure)** | Source: PG&E Calculations 2,976\*0.7= 2,083 kWh/ yr. | Source: PG&E Calculations 783\*0.7=548 Therms/ yr. |
| **Costs Common Units:** | Source: PG&E Calculations $ per fryer vat | Source: PG&E Calculations $ per fryer vat |
| **Base Case Equipment Cost ($/unit):** | Source: PG&E Calculations $4,108 | Source: PG&E Calculations $3,367 |
| **Measure Equipment Cost ($/unit):** | Source: PG&E Calculations $4,876 | Source: PG&E Calculations $4,384 |
| **Measure Incremental Cost ($/unit):** | Source: PG&E Calculations $768 | Source: PG&E Calculations $1,017 |
| **Effective Useful Life (years):** | EULID =  Cook-ElecFryer  12 years –  Source: 2016 DEER | EULID =  Cook-GasFryer  12 years –  Source: 2016 DEER |
| **Program Type:** | Replace on Burnout (ROB), and New Construction (NC). | Replace on Burnout (ROB), and New Construction (NC). |
| **Net-to-Gross Ratios:** | Source: 2016 DEER  NTGID = Com-Default>2yrs | Source: 2016 DEER  NTGID = Com-Default>2yrs |
| **Important Comments:** |  |  |

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# Document Revision History

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Revision #** | | **Date** | **Description** | | **Author (Company)** | |
| **Revision 0** | | 12/11/2007 | Original work paper: Commercial Fryer - Electric and Gas PGECOFST102 R0.doc | | David Zabrowski (Fisher-Nickel, Inc.) | |
| **Revision 1** | | 6/1/2009 | Changes to EUL, NTG language and references, costs updated, corrections to tables and some language | | David Zabrowski, Lauren Mills (Fisher-Nickel, inc.), Steve Blanc PG&E | |
| **Revision 2** | | 3/31/2010 | Updated pricing and incremental cost, Update to DEER 2009-11 NTG file | | David Zabrowski (Fisher-Nickel, inc.), Steve Blanc PG&E | |
| **Revision 3** | | 7/15/2010 | Updated EUL and NTG language per ED comments | | Charlene Spoor (PG&E) | |
| **Revision 4** | | 2/17/2011  7/17/2011 | Updated incremental costs  Reduced UES by 30% per ED Request | | David Zabrowski (Fisher-Nickel, inc.)  Charlene Spoor (PG&E) | |
| **Revision 5** | 6/13/2012  8/22/2012 | | | Updated NTG, EUL and savings analysis. Combined FST102 and FST114  Changed BLD, CZ and VIN to ANY per READI requirements | | David Zabrowski, Kong Sham (Fisher-Nickel, inc.)  Charlene Spoor (PG&E) |
| **Revision 6** | 03/25/2016 | | | Updated new format | | Denis Livchak (Fisher-Nickel, Inc.) |
| **Revision 6** | 8/8/2016 | | | The 30% UES reduction was dropped and it is incorporated in this revision. Updated calc tables to match online calculator ; updated formulas and incorporated examples | | Alina Zohrabian (PG&E)  Mini Damodaran (PG&E) |

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# Section 1. General Measure & Baseline Data

## 1.1 Product Measure Description & Background

This work paper documents the rationale for the Energy Efficient Commercial Fryer (Electric and Gas) measures as listed in the Commercial Food Service Catalog. The Commercial Food Service Catalog is part of Pacific Gas and Electric Company’s Customer Energy Efficiency Program. PG&E offers incentives to non-residential customers for installing qualifying lighting, refrigeration, air-conditioning, food service, and agricultural equipment.

***Catalog Descriptions***

**F205:** The commercial electric fryer (vat width < 18 inches) must meet ENERGY STAR®[[1]](#endnote-1) Version 2.0 specification for energy efficiency or must have a tested heavy load cooking energy efficiency of 80% and an idle energy rate less than or equal to 1,000 W, utilizing ASTM Standard F1361[[2]](#endnote-2).

The commercial electric large vat fryer (vat width ≥ 18 inches) must meet ENERGY STAR® Version 2.0specification for energy efficiency or must have a tested heavy load cooking energy efficiency of 80% and an idle energy rate less than or equal to 1,100 W, utilizing ASTM Standard F2144[[3]](#endnote-3). Multiple vat configurations are paid per qualifying vat.

**F206:** The commercial gas fryer (vat width < 18 inches) must meet ENERGY STAR® Version 2.0 specification for energy efficiency or must have a tested heavy load cooking energy efficiency of 50% and an idle energy rate less than or equal to 9,000 Btu/h, utilizing ASTM Standard F1361.

The commercial gas large vat fryer (vat width ≥ 18 inches) must meet ENERGY STAR® Version 2.0 specification for energy efficiency or must have a tested heavy load cooking energy efficiency of 80% and an idle energy rate less than or equal to 12,000 Btu/h, utilizing ASTM Standard F2144. Multiple vat configurations are paid per qualifying vat.

**SCE 1, SCE 2, SCG 1, and SCG 2:** Southern California Gas and Electric will be further separating out the measure sizes for their programs.

***Program Restrictions and Guidelines***

***Terms and Conditions***

This measure includes new commercial fryers that are ENERGY STAR® qualified or meet the qualifications listed. The qualifications were developed by the California Investor Owned Utilities: [http://www.fishnick.com/saveenergy/rebates/2015\_CFS\_Rebate\_Crite ria-updated\_20150714.pdf](http://www.fishnick.com/saveenergy/rebates/2015_CFS_Rebate_Crite%09ria-updated_20150714.pdf). Used or rebuilt equipment is not eligible. Customers must provide proof that the appliance has a cooking-energy efficiency that meets the requirements in Table 1.

The rebate for F205 and F206 is downstream, provided to the customer at the time of sale, upon receipt of application and invoice. This is not a direct install program.

Table 1. Energy Efficiency Requirements for Commercial Fryers.

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Code** | **Fryer Type** | **Cooking-Energy Efficiency\*** | **Idle Energy Rate** |
| F205 | Electric Fryers (vat width <18 in.) | ≥ 80% | ≤ 1,000 W |
| Electric Fryers (vat width ≥18 in.) | ≥ 80% | ≤ 1,100 W |
| F206 | Gas Fryers (vat width <18 in.) | ≥ 50% | ≤ 9,000 Btu/h |
| Gas Fryers (vat width ≥18 in.) | ≥ 50% | ≤ 12,000 Btu/h |

\*Based on the Heavy-load French fry test

***Market Applicability***

This measure is applicable to any commercial cooking application, including (but not limited to) casual dining and quick service restaurants, hotels, motels, schools, colleges and recreational facilities.

## 1.2 Product Technical Description

Commercial fryers are among the most common pieces of cooking equipment in commercial food service facilities. Recent advances in equipment design have produced fryers that operate more efficiently, quickly, safely and conveniently. Energy efficient commercial fryers reduce energy consumption primarily through advanced burner and heat exchanger design, and through the application of advanced controls and insulation. With the availability of ENERGY STAR® rated models of fryers, it is straightforward to differentiate between high efficiency and standard efficiency models.

All fryers share a common basic design. The fry vat contains a sufficient amount of oil so that the cooking food is essentially supported by displacement of the oil rather than by the bottom of the vessel. Fryers are most often compared on the basis of width and energy-input rating. Taken together, these two numbers suggest the approximate amount of food a fryer can prepare in a given time, which is one of the most important factors in choosing the proper fryer for a kitchen. Fryer with a fry vat less than 18-inches wide is evaluated using ASTM Standard Test Method for thePerformance of Open Deep Fat Fryers (F1361).

Large vat fryers have frypots ranging from 18 x 14 inches to 34 x 34 inches. The most common of these larger vat sizes is the 18 x 18 inches. Large vat fryers are becoming more common in restaurants as they replace smaller (14-inch) fryers to increase production capability while maximizing the available space in the kitchen. This category has historically been driven by the lowest first cost and, until recently, has traditionally not employed energy-efficient technologies. Large vat fryer performance is determined by applying the ASTM Standard Test Method for thePerformance of Large Vat Fryers (F2144).

Energy efficient fryers that have earned the ENERGY STAR® qualification offer shorter cook times and higher production rates. Frypot insulation reduces standby losses resulting in a lower idle energy rate. The ASTM standard test methods are considered the industry standard for quantifying the efficiency and performance of open deep fat fryers.

## 1.3 Measure Application Types

Table 2. Measure Application Type

|  |  |  |
| --- | --- | --- |
| **Code** | **Description** | **Comment** |
| ER | Early retirement | *measure applied while existing equipment still viable, or retrofit of existing equipment* |
| ROB | Replace on Burnout | *measure applied when existing equipment fails or maintenance requires replacement* |
| NC | New Construction | *measure applied during construction design phase as an alternative to a code-compliant standard design* |

Since there are no EM&V studies on the useful life of commercial fryers and it is standard practice in the commercial foodservice industry to purchase equipment only when it is needed (e.g., replacement or additional capacity), this measure is focused on ROB and NC applications only.

## 1.4 Product Base Case and Measure Case Data

### 1.4.1 DEER Base Case and Measure Case Information

The DEER database does not contain information on energy use or savings for an energy-efficient electric or gas commercial fryer measure. The only reference in DEER for Commercial cooking equipment is for Estimated Useful Life.

**Hours of Operation**

This Work Paper assumes a 14-hour daily operating period over 365 days per year, or 5,110 hours per year. Annual hours of operation were based on market based research in collaboration with the California Energy Commission found in Appendix E Table E-4: <http://www.energy.ca.gov/2014publications/CEC-500-2014-095/CEC-500-2014-095.pdf>

**Base Case & Measure Case Costs**

The base case and measure case costs are calculated are found in section 4.

***Net-to-Gross Assumptions***

DEER NTGR Values file does not specifically list commercial food service appliances. The default used for non-residential measures is 0.6[[4]](#endnote-4).

Table 3 summarizes all applicable DEER based Net-to-Gross ratios for programs that may be used by this measure.

Table 3. DEER 2016 Net-to-Gross Ratios

|  |  |
| --- | --- |
|  |  |
| NTG-ID | NTG |
| Com-Default>2yrs | 0.6 |

**Effective Useful Lives**

DEER database shows a EUL of 12 years and an RUL of 4 years[[5]](#endnote-5) for all cooking appliance measures, including electric and gas commercial fryers.

Table 4. DEER Effective Useful Life

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Code** | **EUL (yrs.)** | **RUL (yrs.)** | **DEER Version** | **EULID** |
| F205 | 12 | N/A | DEER2016 | Cook- ElecFryer |
| F206 | 12 | N/A | DEER2016 | Cook- GasFryer |

**In Service Rate/ First Year Installation Rate**

The IR values were obtained using the DEER READI tool. The relevant IR values for the measures in this work paper are in the table below.

Table 5. Installation Rate

|  |  |  |  |
| --- | --- | --- | --- |
| **GSIA ID** | **Description** | **Sector** | **GSIA Value** |
| Def-GSIA | Default GSIA values | Com | 1 |

### 1.4.2 Codes & Standards Requirements Base Case and Measure Information

#### California Title 20

State of California Title 20 Appliance Efficiency Regulation[[6]](#endnote-6) has a category for cooking appliances, but fryers are not included.

#### California Title 24

There are no State of California Title 24 Efficiency Regulation requirements for commercial fryers.

**Federal**

There are no Federal energy efficiency requirements for commercial fryers.

#### American Society for Testing and Materials (ASTM) Standards

ASTM Standard Test Method for thePerformance of Open Deep Fat Fryers (F1361) and Large Vat Fryer (2144) are applicable for estimating energy use and cooking performance. They are used to estimate the energy consumption of the base case and measure equipment.

### 1.4.3 EM&V, Market Potential, and Other Studies – Base Case and Measure Case Information

There were no specific EM&V studies identified that addressed cooking measures in the commercial sector.

### 1.4.4 Assumptions and Calculations from other sources—Base and Measure Cases

This Work Paper uses ASTM Standard Test Method for the Performance of Open Deep Fat Fryers (F1361) and the ASTM Standard Test Method for the Performance of Large Vat Fryers (F2144) for calculation of energy use and demand, based on testing in an approved and qualified laboratory. In the absence of mandatory regulations for testing commercial fryers, there is little incentive on the part of equipment manufacturers to have their baseline equipment tested. Therefore, the ASTM performance parameters for baseline equipment were drawn from a sample of economy grade equipment tested by the Food Service Technology Center and is summarized in Table 6.

Table 6. Baseline ASTM test results for Commercial Fryers.

|  |  |  |  |
| --- | --- | --- | --- |
| **Fryer Type** | **Idle Energy Rate** | **Cooking-Energy Efficiency\*** | **Production Capacity\*** |
| Electric Fryers | 1,200 W | 75% | 65 lb/h |
| Gas Fryers | 17,000 Btu/h | 35% | 60 lb/h |

\*Based on the Heavy-load French fry test in ASTM F1361.

The measure case data was drawn from the list of commercial fryers that have been tested by IOU testing laboratories as of April 20, 2012.

Table 7. Measure ASTM test results for Commercial Fryers.

|  |  |  |  |
| --- | --- | --- | --- |
| **Fryer Type** | **Idle Energy Rate** | **Cooking-Energy Efficiency\*** | **Production Capacity\*** |
| Electric Fryers | 860 W | 85% | 71 lb/h |
| Gas Fryers | 6,371 Btu/h | 57% | 67 lb/h |

\*Based on the Heavy-load French fry test in ASTM F1361.

The Food Service Technology Center conducted an assessment of major commercial cooking appliance technologies, which included a chapter on fryers.[[7]](#endnote-7) Since commercial fryers are currently not covered by state or national codes, the base case for existing models of fryers was determined from Table 2.1 in the Food Service Technology Center assessment.

**Hours of Operation**: This Work Paper assumes a 14-hour daily operating period over 365 days per year, or 5,110 hours per year. This 14-hour operating day is consistent with typical Quick Service Restaurant (QSR) operating hours, which range from 14 to 24 hours per day. Since energy efficient fryers represent a fairly significant initial cost investment over standard fryers, this measure is targeted for heavy-use operations that regularly produce a large volume (e.g., 150 pounds per day per fryer) of fried food. This Work Paper is based on the calculation methods in ASTM Standard Test Method for the Performance of Open Deep Fat Fryers (F1361), which uses measured data under preheat, idle, and heavy-load cooking conditions.

Table 8. Hours of Operation

|  |  |  |
| --- | --- | --- |
| **Hours of Operation hrs./yr.** | **Reference** | **Measure code** |
| 5110 | ASTM1361 | F205 |
| 5110 | ASTM1361 | F206 |

Building variations were averaged across all quick serve and full serve restaurant types throughout California.

**Effective Useful Life:**EUL values were downloaded and used directly from DEER

DEER2016 database shows a EUL of 12 years and an RUL of 4 years for all cooking appliance measures, including electric and gas fryers.

**Net-to-Gross Assumption:** NTG values were downloaded and used directly from DEER.

**In-service rate/first year installation rate**: ISR is assumed to be 1 based on engineering expertise.

### 1.4.5 Time of use Adjustment Factor

The TOU adjustment factor for all non A/C measures is 0.

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# Section 2. Calculation Methods

**The UES (Unit Energy Savings) savings are adjusted based on Decision 11-07-030, and comments in Attachment A, which stated “Energy Division believes that operating hours, food production rates and baseline efficiencies contribute to overly optimistic UES calculations and recommend a 30% reduction in UES values”. Therefore the final claimable UES numbers are adjusted down 30% and shown in table below.**

Table 9: Final claimable savings

|  |  |  |
| --- | --- | --- |
| **Performance** | **Estimated savings** | **Claimable savings after 30% reduction** |
| **Commercial Fryer (Electric) – Annual kWh savings** | **2,976** | **2976\*0.7=2,083** |
| **Commercial Fryer (Electric) - Peak kW savings** | **0.45** | **0.45\*0.7=0.315** |
| **Commercial Fryer (Gas) - Annual therm savings** | **783** | **783\*0.7=548** |

## 2.1 Electric Energy Savings Estimation Methodologies

The industry standards for energy use and cooking performance of fryers are ASTM Standard Test Method for thePerformance of Open Deep Fat Fryers (F1361) and ASTM Standard Test Method for thePerformance of Large Vat Fryers (F2144). Table 10 shows an example of the calculation results for electric fryers based on ASTM test results. To simplify the calculation the preheat time is assumed to be 15 min, since the industry standard preheat time is from 10-20min.

Table 10. Commercial Electric Fryer Cost Effectiveness Example.

|  |  |  |
| --- | --- | --- |
| **Performance** | **Baseline Model** | **Energy Efficient Model** |
| Fryer Size (inches) | 14 | 14 |
| Preheat Energy (kWh) | 2.40 | 1.90 |
| Idle Energy Rate (kW) | 1.20 | 0.86 |
| Heavy Load Cooking Energy Efficiency (%) | 75 | 85 |
| Production Capacity (lbs/hr) | 65 | 71 |
| Operating Hours/Day | 14 | 14 |
| Operating Days/Year | 365 | 365 |
| Number of Preheats per Day (#/day) | 1 | 1 |
| Pounds of Food Cooked per Day | 150 | 150 |
| ASTM Energy to Food (kWh/lb)a | 0.167 | 0.167 |
| Daily Energy Consumption (kWh) | 49.5 | 41.4 |
| Average Demand (kW) | 3.5 | 3.0 |
| Estimated Demand Reduction (kW) | - | 0.5 |
| Actual Demand Reduction with CDF of 0.9 (kW) |  | **0.45** |
| Annual Energy Consumption (kWh) | 18,079 | 15,103 |
| Estimated Energy Savings (kWh/yr) | - | **2,976** |
| Estimated Useful Life (EUL)b | 12 years | 12 years |

a This is the average value calculated by FSTC through ASTM F1964 test through weight and temperature measurement of test product cooked in fryers ovens (570 Btu/lb for frozen French Fry); 570/3412=0.167

[http://www.fishnick.com/publications/appliancereports/fryers/](https://urldefense.proofpoint.com/v2/url?u=http-3A__www.fishnick.com_publications_appliancereports_fryers_&d=CwMFAg&c=hLS_V_MyRCwXDjNCFvC1XhVzdhW2dOtrP9xQj43rEYI&r=TlrXy5TrK8nTfd5c4pv-ow&m=cFsehyMI40glhUaTorENjwTfazRVidY2T4fM1NiXXL8&s=kpbRqoUI3awxhfyGUJSA3wLKsw1sq3KHFH4nDOplMY0&e=)

b The estimated useful life is based on DEER EUL estimates.

**Daily Energy Consumption Calculation and Definitions**

Where:

|  |  |
| --- | --- |
| EDAY = | Calculated Daily Energy Consumption (kWh/day) |
| LBFOOD = | Estimated Pounds of Food Cooked per Day |
| EFOOD = | ASTM Energy to Food (kWh/lb) = kWh/pound of energy absorbed by food product during cooking |
| EFFICIENCY = | Measured Heavy Load Cooking Energy Efficiency % |
| IDLE RATE = | Measured Idle Energy Rate (kW) |
| EHOU= | Estimated Operating Hours/Day |
| PC = | Measured Production Capacity (lbs/hr) |
| TP = | Estimated Preheat Time (min) |
| nP = | Estimated Number of preheats/Day |
| EP = | Measured Preheat Energy (kWh) |

**Daily Energy Consumption Example:**

Hand calculation may generate slightly different number due to rounding to significant digits.

## 2.2. Demand Reduction Estimation Methodologies

A fryer’s actual contribution to a building’s peak demand may vary significantly depending on its usage pattern in relation to that of other electric equipment in the facility (operating schedule, appliance on time, etc.). The probability of an appliance drawing its average rate during the period that the building peak is set is significantly higher than for any other input rate for that appliance. Therefore, it has been assumed that the probable contribution to the building’s peak demand is equal to the appliance’s average demand.

The demand reduction estimation is based on measured data for standard efficiency electric fryers (no fry pot insulation and mechanical or simple electronic controls) and for high efficiency fryers that meet Energy Star requirements (greater than 80% cooking efficiency, fry pot insulation, and advanced electronic controls). The measured data are derived from tests conducted under ASTM Standard Test Method for thePerformance of Open Deep Fat Fryers (F1361) and ASTM Standard Test Method for thePerformance of Large Vat Fryers (F2144).

The ASTM test methods provide standard conditions under which fryer energy use is measured. The estimated demand reduction of 500 Watts is based on data from tests of standard efficiency and high efficiency fryers. Applying a Coincidence Factor of 0.9 for food service establishments using the professional judgement of the Food Service Technology Center, yields a Demand savings of 450 Watts for the electric fryer.

## 2.3. Gas Energy Savings Estimation Methodologies

The industry standard for energy use and cooking performance of deep fat fryers is ASTM Standard Test Method for thePerformance of Fryers (F1361) and ASTM Standard Test Method for thePerformance of Large Vat Fryers (F2144). Table 11 shows an example of the calculation results for gas fryers under ASTM test results.

Table 11. Commercial Gas Fryer Cost Effectiveness Example.

|  |  |  |
| --- | --- | --- |
| **Performance** | **Baseline Model** | **Energy Efficient Model** |
| Fryer Size (inches) | 14 | 14 |
| Preheat Energy (Btu) | 18,500 | 16,000 |
| Idle Energy Rate (Btu/hr) | 17,000 | 6371 |
| Heavy Load Cooking Energy Efficiency (%) | 35 | 57 |
| Production Capacity (lbs/hr) | 60 | 67 |
| Operating Hours/Day | 14 | 14 |
| Operating Days/Year | 365 | 365 |
| Number of Preheats per Day (#/day) | 1 | 1 |
| Pounds of Food Cooked per Day | 150 | 150 |
| ASTM Energy to Food (Btu/lb.)a | 570 | 570 |
| Daily Energy Consumption (Btu) | 454,034 | 239,344 |
| Annual Energy Consumption (therms)b | 1,657 | 874 |
| Estimated Energy Savings (therms/yr) | - | **783** |
| Estimated Useful Life (EUL)c | 12 years | 12 years |

a This is the average value calculated by FSTC through ASTM F1964 test through weight and temperature measurement of test product cooked in fryers ovens (570 Btu/lb for frozen French Fry)

[http://www.fishnick.com/publications/appliancereports/fryers/](https://urldefense.proofpoint.com/v2/url?u=http-3A__www.fishnick.com_publications_appliancereports_fryers_&d=CwMFAg&c=hLS_V_MyRCwXDjNCFvC1XhVzdhW2dOtrP9xQj43rEYI&r=TlrXy5TrK8nTfd5c4pv-ow&m=xiQt0BJefxi1OOdFkKZw68uwF1ADiFrzRTcIJvZNzVQ&s=TptihWlQ9sKjCybcFb0IXIslEuJT16JOnGgg90pMakQ&e=)

b 1 therm = 100,000 Btu.

c The estimated useful life is based on DEER EUL estimates.

**Daily Energy Consumption Calculation and Definitions**

Where:

|  |  |
| --- | --- |
| EDAY = | Calculated Daily Energy Consumption (Btu/day) |
| LBFOOD = | Estimated Pounds of Food Cooked per Day |
| EFOOD = | ASTM Energy to Food (Btu/lb) = Btu/pound of energy absorbed by food product during cooking |
| EFFICIENCY = | Measured Heavy Load Cooking Energy Efficiency % |
| IDLE RATE = | Measured Idle Energy Rate (Btu/h) |
| EHOU= | Estimated Operating Hours/Day |
| PC = | Measured Production Capacity (lbs/hr) |
| TP = | Estimated Preheat Time (min) |
| nP = | Estimated Number of preheats/Day |
| EP = | Measured Preheat Energy (Btu) |

**Daily Energy Consumption Example:**

Hand calculation may generate slightly different number due to rounding to significant digits.

# Section 3. Load Shapes

Load Shapes are an important part of the life-cycle cost analysis of any energy efficiency program portfolio. The net benefits associated with a measure are based on the amount of energy saved and the avoided cost per unit of energy saved. For electricity, the avoided cost varies hourly over an entire year. Thus, the net benefits calculation for a measure requires both the total annual energy savings (kWh) of the measure and the distribution of that savings over the year. The distribution of savings over the year is represented by the measure’s load shape. The measure’s load shape indicates what fraction of annual energy savings occurs in each time period of the year. An hourly load shape indicates what fraction of annual savings occurs for each hour of the year. A Time-of-Use (TOU) load shape indicates what fraction occurs within five or six broad time-of-use periods, typically defined by a specific utility rate tariff. Formally, a load shape is a set of fractions summing to unity, one fraction for each hour or for each TOU period. Multiplying the measure load shape with the hourly avoided cost stream determines the average avoided cost per kWh for use in the life cycle cost analysis that determines a measure’s Total Resource Cost (TRC) benefit.

## 3.1 Base Case Load Shapes

The base case load shape would be expected to follow a typical non-residential foodservice end use load shape.

Commercial fryer load shapes differ among food service facilities (quick service, casual dining, hotels, college, schools, hospitals, etc.) depending on daily menu variations, hours of operation, serving periods, day-of-week, and facility location (city downtown, suburban mall, access to interstate highways, etc.). Consequently, applicable average TOU and hourly load shapes for commercial fryers are unavailable. The ASTM Standard Test Method used to generate energy use data is based on hours of use and operating state (preheat, idle, and heavy-load cooking). Generally, commercial fryers are used to prepare food within a few days to a few hours before it is served, so loads tend to not necessarily be coincident with regular meal periods (breakfast, lunch, and dinner). Between meal periods commercial fryers may be used to prepare ingredients for either the next meal period or for menu items to be served the next several days (in which case the ingredients are refrigerated immediately after cooking).

## 

## 3.2 Measure Load Shapes

For purposes of the net benefits estimates in the E3 calculator, what is required is the load shape that ideally represents the *difference* between the base equipment and the installed energy efficiency measure. This *difference* load profile is what is called the Measure Load Shape and would be the preferred load shape for use in the net benefits calculations.

The measure load shape for this measure is determined by the E3 calculator based on the applicable non-residential market sector and the foodservice end-use.

The electric demand profile for the high-efficiency electric commercial fryer is expected to be the same as the Base Case. The profile will vary as explained in Section 3.1. The Measure Load Shape for the high-efficiency commercial fryers will use less energy and have a lower demand profile.

The gas load profile for the high efficiency gas commercial fryers is expected to be the same as the Base Case. The profile will vary as explained in Section 3.1. The Measure Load Shape for the high efficiency commercial fryers will use less energy.

# Section 4. Base Case & Measure Costs

High efficiency fryers typically list for more than standard efficiency fryers. However, high efficiency designs are often bundled with other features such as all stainless steel construction and high quality components and controls. In addition to lower operating costs, high efficiency fryers exhibit higher production rates and shorter recovery times than Baseline model fryers and in some cases may eliminate the need for a backup fryer.

Equipment prices for these work papers were compiled from a number of sources including, Autoquotes, equipment sales reps and manufacturer sources[[8]](#endnote-8). Since equipment pricing in food service is closely held information and prices vary widely according to buying volume and other factors, we cannot list the sources for prices specifically.

## 4.1 Base Cases Costs

The Base Case costs include only the equipment. High efficiency fryers require no additional labor or maintenance compared to base case fryers. Since this measure is applicable for ROB and NC installations, the installation and maintenance costs are expected to be the same for the customer. The estimated equipment cost is based on recent list cost data for electric and gas fryers and applying an industry-standard 50% discount to the manufacturer published list prices.

## 4.2 Measure Costs

The Measure costs include only the equipment, as explained in Section 4.1. The estimated equipment cost is based on recent list cost data (see Appendix A).

## 4.3 Incremental & Full Measure Costs

Incremental measure costs are used in the analysis.

Table 12. Equipment Incremental Cost Data for Energy Efficient Commercial Fryers

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Baseline Unit List Price** | **Energy Efficient Unit List Price** | **Incremental List Price Difference** | **Baseline Unit Cost** | **Energy Efficient Unit Cost** | **Incremental Measure Cost (IMC)** |
| Electric Fryer (F205) | $8,215 | $9,753 | $1,537 | $4,108 | $4,876 | $768 |
| Gas Fryer (F206) | $6,733 | $8,768 | $2,034 | $3,367 | $4,384 | $1,017 |

\*Estimated purchase price and Incremental Measure Cost (IMC) were based on list prices from AutoQuotes catalog in 2011

# Appendix A

**Equipment Cost Data for Electric Fryers Updated 2011**

| Designation | Group | Size | List Price ($) | Cost ($)\* |
| --- | --- | --- | --- | --- |
| B1 | Baseline | Fryer | $5,845 | $2,923 |
| B2 | Baseline | Fryer | $5,845 | $2,923 |
| B3 | Baseline | Fryer | $9,543 | $4,772 |
| B4 | Baseline | Fryer | $8,879 | $4,440 |
| B5 | Baseline | Fryer | $10,090 | $5,045 |
| B6 | Baseline | Fryer | $9,515 | $4,758 |
| B7 | Baseline | Fryer | $10,364 | $5,182 |
| B8 | Baseline | Fryer | $4,861 | $2,431 |
| B9 | Baseline | Fryer | $5,481 | $2,741 |
| B10 | Baseline | Fryer | $4,891 | $2,446 |
| B11 | Baseline | Large Vat | $9,386 | $4,693 |
| B12 | Baseline | Large Vat | $10,550 | $5,275 |
| B13 | Baseline | Large Vat | $13,821 | $6,911 |
| B14 | Baseline | Large Vat | $7,870 | $3,935 |
| B15 | Baseline | Large Vat | $8,216 | $4,108 |
| B16 | Baseline | Large Vat | $6,156 | $3,078 |
| B17 | Baseline | Large Vat | $6,218 | $3,109 |
| B18 | Baseline | Large Vat | $7,204 | $3,602 |
| B19 | Baseline | Large Vat | $8,031 | $4,016 |
| B20 | Baseline | Large Vat | $9,938 | $4,969 |
| B21 | Baseline | Large Vat | $9,810 | $4,905 |
| EE1 | Energy Efficient | Fryer | $6,850 | $3,425 |
| EE2 | Energy Efficient | Fryer | $9,800 | $4,900 |
| EE3 | Energy Efficient | Fryer | $7,920 | $3,960 |
| EE4 | Energy Efficient | Fryer | $10,830 | $5,415 |
| EE5 | Energy Efficient | Fryer | $8,696 | $4,348 |
| EE6 | Energy Efficient | Fryer | $11,580 | $5,790 |
| EE7 | Energy Efficient | Fryer | $4,414 | $2,207 |
| EE8 | Energy Efficient | Fryer | $17,762 | $8,881 |
| EE9 | Energy Efficient | Fryer | $15,806 | $7,903 |
| EE10 | Energy Efficient | Fryer | $15,804 | $7,902 |
| EE11 | Energy Efficient | Fryer | $9,400 | $4,700 |
| EE12 | Energy Efficient | Fryer | $8,548 | $4,274 |
| EE13 | Energy Efficient | Fryer | $7,926 | $3,963 |
| EE14 | Energy Efficient | Fryer | $8,524 | $4,262 |
| EE15 | Energy Efficient | Fryer | $6,566 | $3,283 |
| EE16 | Energy Efficient | Fryer | $7,576 | $3,788 |
| EE17 | Energy Efficient | Fryer | $7,854 | $3,927 |
| EE18 | Energy Efficient | Large Vat | $9,692 | $4,846 |

\*Estimated purchase price and Incremental Measure Cost (IMC) were based on list prices from AutoQuotes catalog in 2011

**Equipment Cost Data for Gas Commercial Fryers Updated 2011**

| Designation | Group | Size | List Price ($) | Cost ($)\* |
| --- | --- | --- | --- | --- |
| B1 | Baseline | Fryer | $7,819 | $3,910 |
| B2 | Baseline | Fryer | $8,059 | $4,030 |
| B3 | Baseline | Fryer | $4,419 | $2,210 |
| B4 | Baseline | Fryer | $4,982 | $2,491 |
| B5 | Baseline | Fryer | $10,063 | $5,032 |
| B6 | Baseline | Fryer | $5,082 | $2,541 |
| B7 | Baseline | Fryer | $5,729 | $2,865 |
| B8 | Baseline | Fryer | $7,393 | $3,697 |
| B9 | Baseline | Fryer | $3,772 | $1,886 |
| B10 | Baseline | Fryer | $6,654 | $3,327 |
| B11 | Baseline | Fryer | $6,047 | $3,024 |
| B12 | Baseline | Fryer | $7,687 | $3,844 |
| B13 | Baseline | Fryer | $7,920 | $3,960 |
| B14 | Baseline | Fryer | $6,860 | $3,430 |
| B15 | Baseline | Fryer | $7,556 | $3,778 |
| B16 | Baseline | Fryer | $2,628 | $1,314 |
| B17 | Baseline | Fryer | $3,264 | $1,632 |
| B18 | Baseline | Fryer | $5,086 | $2,543 |
| B19 | Baseline | Fryer | $6,249 | $3,125 |
| B20 | Baseline | Fryer | $10,382 | $5,191 |
| B21 | Baseline | Fryer | $8,652 | $4,326 |
| B22 | Baseline | Fryer | $6,986 | $3,493 |
| B23 | Baseline | Fryer | $7,826 | $3,913 |
| B24 | Baseline | Fryer | $5,778 | $2,889 |
| B25 | Baseline | Fryer | $6,686 | $3,343 |
| B26 | Baseline | Fryer | $9,510 | $4,755 |
| B27 | Baseline | Fryer | $5,596 | $2,798 |
| B28 | Baseline | Fryer | $8,071 | $4,036 |
| B29 | Baseline | Fryer | $6,670 | $3,335 |
| B30 | Baseline | Fryer | $4,842 | $2,421 |
| B31 | Baseline | Fryer | $6,306 | $3,153 |
| B32 | Baseline | Fryer | $7,277 | $3,639 |
| B33 | Baseline | Fryer | $9,670 | $4,835 |
| B34 | Baseline | Fryer | $4,570 | $2,285 |
| B35 | Baseline | Large Vat | $7,687 | $3,844 |
| B36 | Baseline | Large Vat | $11,188 | $5,594 |
| B37 | Baseline | Large Vat | $17,540 | $8,770 |
| B38 | Baseline | Large Vat | $8,816 | $4,408 |
| B39 | Baseline | Large Vat | $9,708 | $4,854 |
| B40 | Baseline | Large Vat | $3,010 | $1,505 |
| B41 | Baseline | Large Vat | $3,950 | $1,975 |
| B42 | Baseline | Large Vat | $11,170 | $5,585 |
| B43 | Baseline | Large Vat | $6,278 | $3,139 |
| B44 | Baseline | Large Vat | $10,968 | $5,484 |
| B45 | Baseline | Large Vat | $10,100 | $5,050 |
| B46 | Baseline | Large Vat | $6,466 | $3,233 |
| B47 | Baseline | Large Vat | $5,562 | $2,781 |
| B48 | Baseline | Large Vat | $10,538 | $5,269 |
| B49 | Baseline | Large Vat | $9,796 | $4,898 |
| B50 | Baseline | Large Vat | $10,764 | $5,382 |
| B51 | Baseline | Large Vat | $9,004 | $4,502 |
| B52 | Baseline | Large Vat | $7,284 | $3,642 |
| B53 | Baseline | Large Vat | $7,284 | $3,642 |
| B54 | Baseline | Large Vat | $11,945 | $5,973 |
| B55 | Baseline | Large Vat | $7,340 | $3,670 |
| B56 | Baseline | Large Vat | $7,854 | $3,927 |
| B57 | Baseline | Large Vat | $7,932 | $3,966 |
| B58 | Baseline | Large Vat | $7,819 | $3,910 |
| EE1 | Energy Efficient | Fryer | $8,059 | $4,030 |
| EE2 | Energy Efficient | Fryer | $4,419 | $2,210 |
| EE3 | Energy Efficient | Fryer | $4,982 | $2,491 |
| EE4 | Energy Efficient | Fryer | $10,063 | $5,032 |
| EE5 | Energy Efficient | Fryer | $5,082 | $2,541 |
| EE6 | Energy Efficient | Fryer | $5,729 | $2,865 |
| EE7 | Energy Efficient | Fryer | $7,393 | $3,697 |
| EE8 | Energy Efficient | Fryer | $3,772 | $1,886 |
| EE9 | Energy Efficient | Fryer | $6,654 | $3,327 |
| EE10 | Energy Efficient | Fryer | $6,047 | $3,024 |
| EE11 | Energy Efficient | Fryer | $7,687 | $3,844 |
| EE12 | Energy Efficient | Fryer | $7,920 | $3,960 |
| EE13 | Energy Efficient | Large Vat | $6,860 | $3,430 |
| EE14 | Energy Efficient | Large Vat | $7,556 | $3,778 |
| EE15 | Energy Efficient | Large Vat | $2,628 | $1,314 |
| EE16 | Energy Efficient | Large Vat | $3,264 | $1,632 |

\*Estimated purchase price and Incremental Measure Cost (IMC) were based on list prices from AutoQuotes catalog in 2011

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7. 7 Fisher-Nickel, inc., D. Fisher, et al., 2002. Commercial Cooking Appliance Technology Assessment. Food Service Technology Center Report 5011.02.26, pp. 2-1 to 2-24.

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8. 8 AutoQuotes electronic catalog for foodservice equipment and supplies <http://www.aqnet.com/> [↑](#endnote-ref-8)