APRIL 23 – 24, 2014
CRYSTAL GATEWAY MARRIOTT • ARLINGTON, VIRGINIA
International Emerging Technology Symposium

Innovative Technologies [and Design Concepts] in Commercial Foodservice

Food Service Technology Center PG&E

Don Fisher, P. Eng.
Fisher Consultants
PG&E Food Service Technology Center
925-866-5770 dfisher@fishnick.com

Food Service Technology Center: Who? What? Why?

The Food Service Technology Center (FSTC) is an unbiased energy-efficiency research program funded by California utility customers.

Specializing in commercial food service.

Promoting energy efficiency and performance

Celebrating 27 years of hard work!

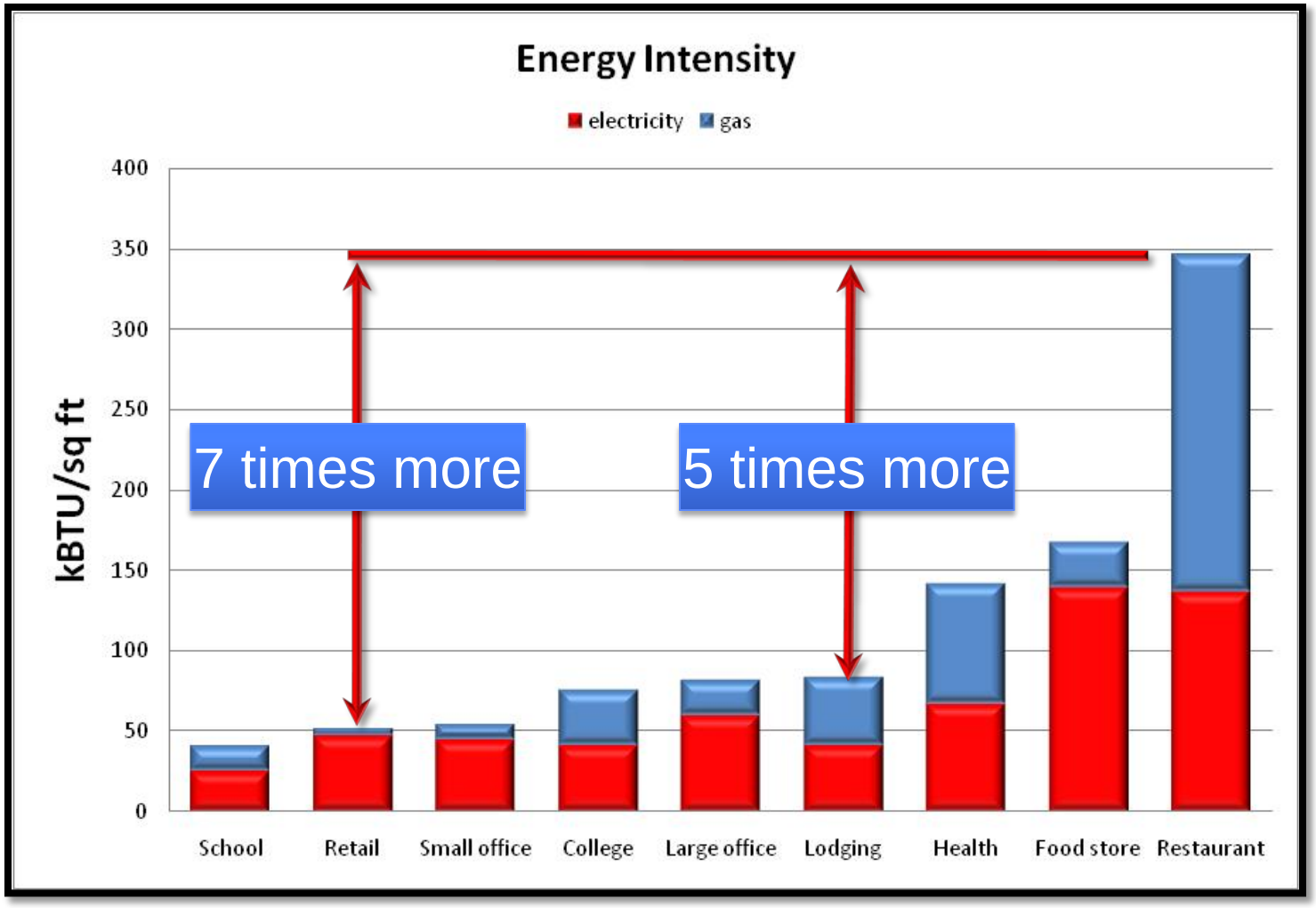

FOOD SERVICE
TECHNOLOGY CENTER
PROMOTING ENERGY EFFICIENCY IN FOODSERVICE
1.800.398.3782
Enter search criteria
About
Save Energy
Save Water
Design
Equipment
Testing
Education
Ventilation
Publications
rebate info
design guides
cost calculators
seminars
energy tips
contact information
fishnick.com

Food Service Technology Center

PG&E

Our Mission is to bring “MPG” and Performance information to the entire commercial food service world.

Why? Food Service is Energy Intensive!

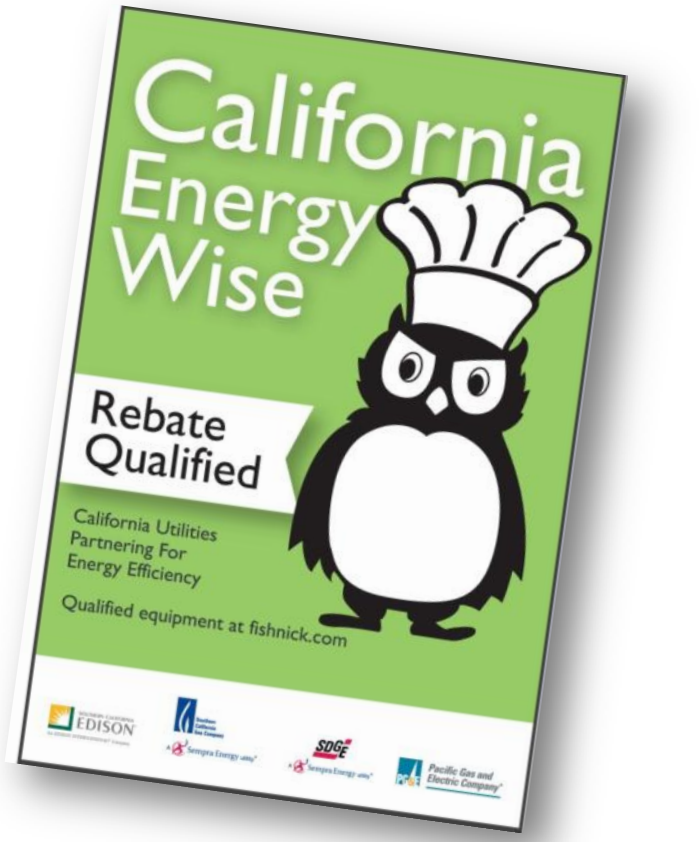


Source: www.energy.ca.gov/2006publications/CEC-400-2006-005/CEC-400-2006-005.PDF

Food Service Technology Center

PG&E

We've had some major success:



ENERGY STAR Categories

www.energystar.gov/cfs

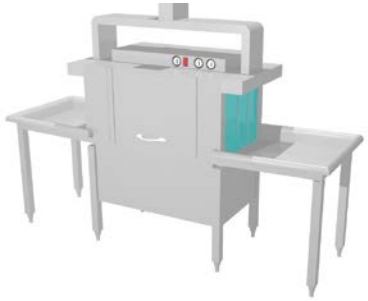
Refrigeration

Hot Holding Cabinets

Fryers

Steamers

Griddles



Dish Machines

Ice Machines

Convection Ovens

Appliance Testing Laboratory

– create ASTM Standard Test Methods

&

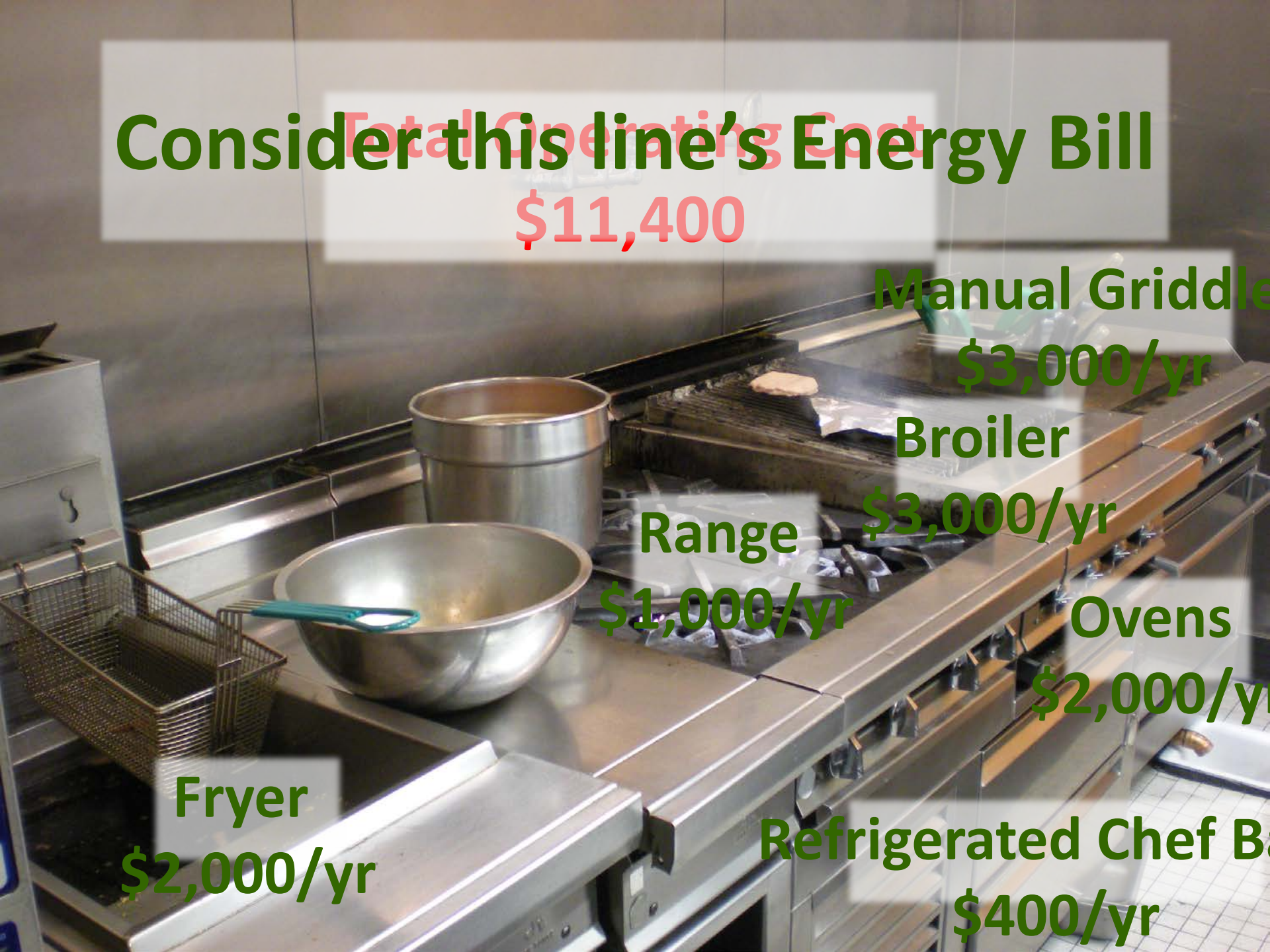
"miles-per-gallon" numbers for appliances

The controlled environment "levels the playing field."

A single appliance can consume more energy per year than your home!

>

If your had to gas each appliance every morning, one's perspective would quickly change…


Consider this line's Energy Bill
Total Operating Cost
$11,400
Manual Griddle
$3,000/yr
Broiler
$3,000/yr
Range
$1,000/yr
Ovens
$2,000/yr
Fryer
$2,000/yr
Refrigerated Chef B
$400/yr

Each commercial kitchen can include dozens of energy uses.

Example: A typical McDonald's kitchen has about 70 different pieces of gas and electric equipment.

What have we learned?

Appliances are not created equal!

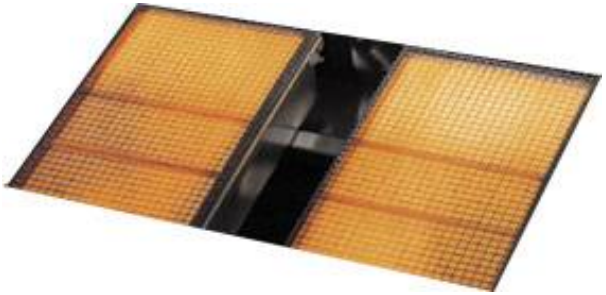
What makes an appliance more efficient?

Induction

Good Heat Exchange

Smart Controls

Insulation



Powered or
IR Burners

...less efficient?

Poor Heat Exchange

Low-Cost Components

No Insulation

Manual Control

Dead giveaway for an Inefficient Fryer

Cast Iron Burner

Insulation Saves Energy!

40% Reduction in Energy Use

…at $0.90 per therm!

- Rated input: 144,000 Btu/hr
- Assume average consumption of 100,000 Btu/h
- Over a 10 hr Day
- 360 days per year
- @ $0.90/therm

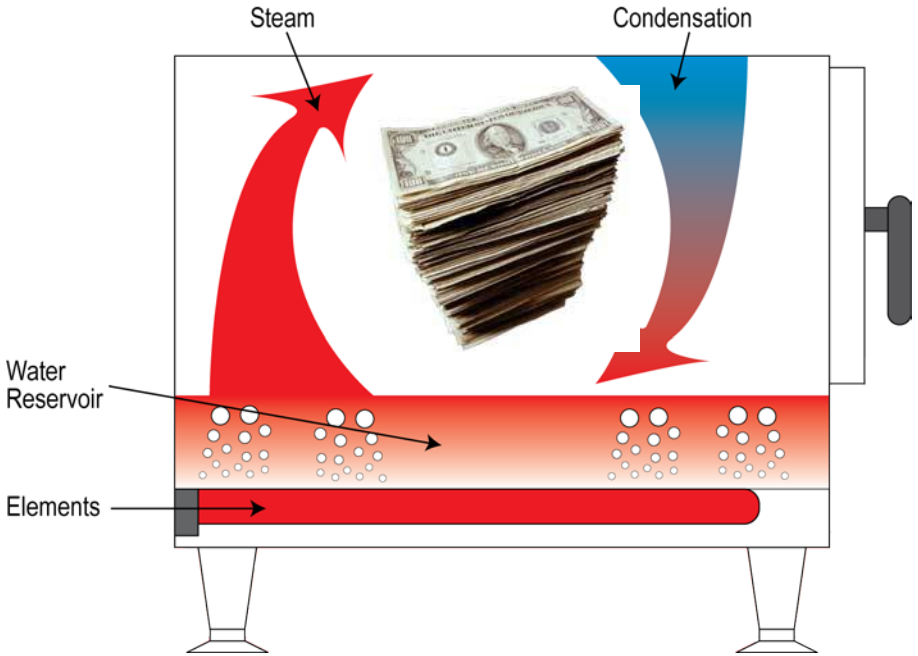
100,000 Btu/h = 1 therm, so..

1 therm x 10 hr x 360 days = 3600 therms/yr

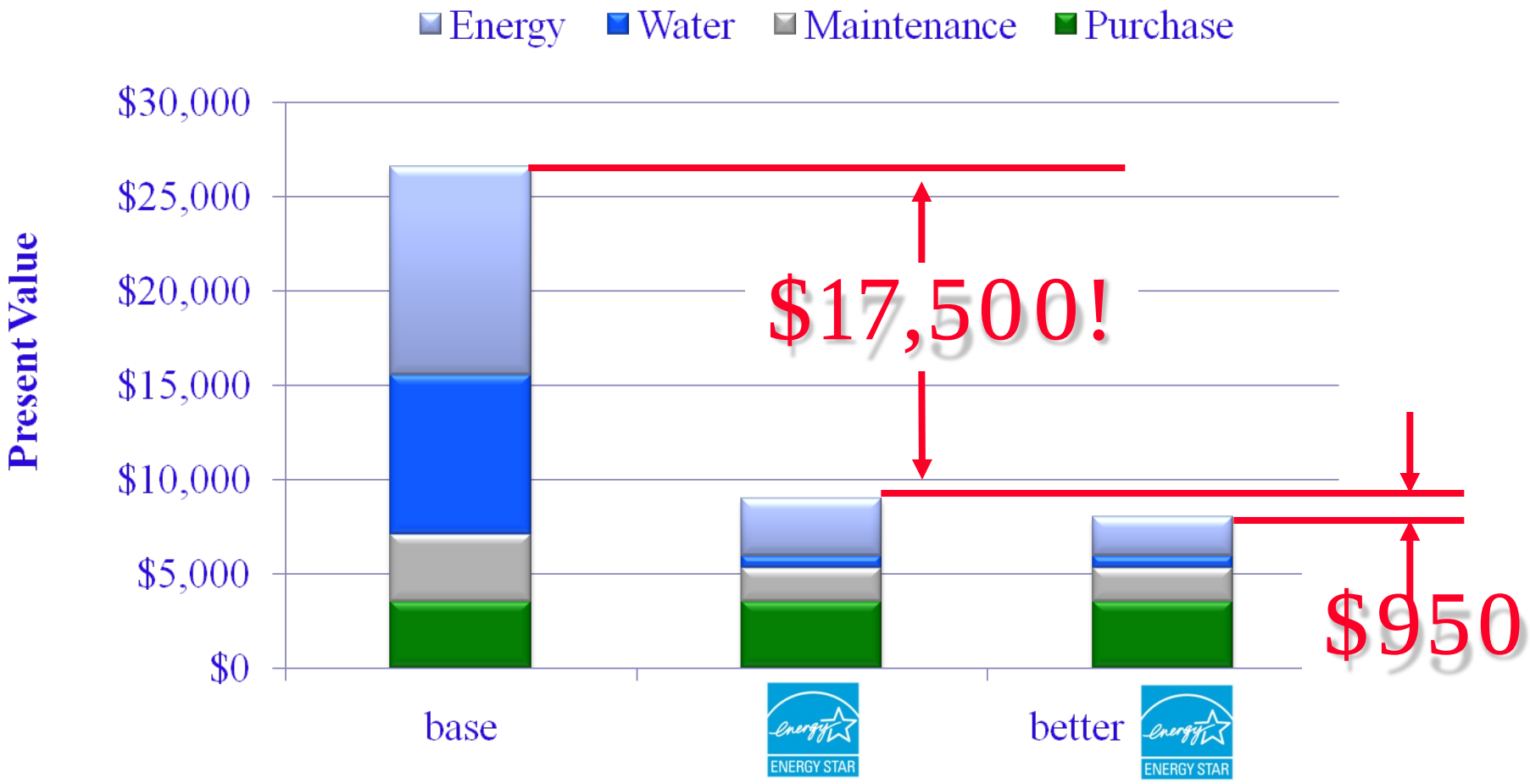
= 3600 therms x $0.90 = **$3240/yr!**

Why not a lid?

The Steamer Challenge:
The closed-system steamer is much more energy and water efficient



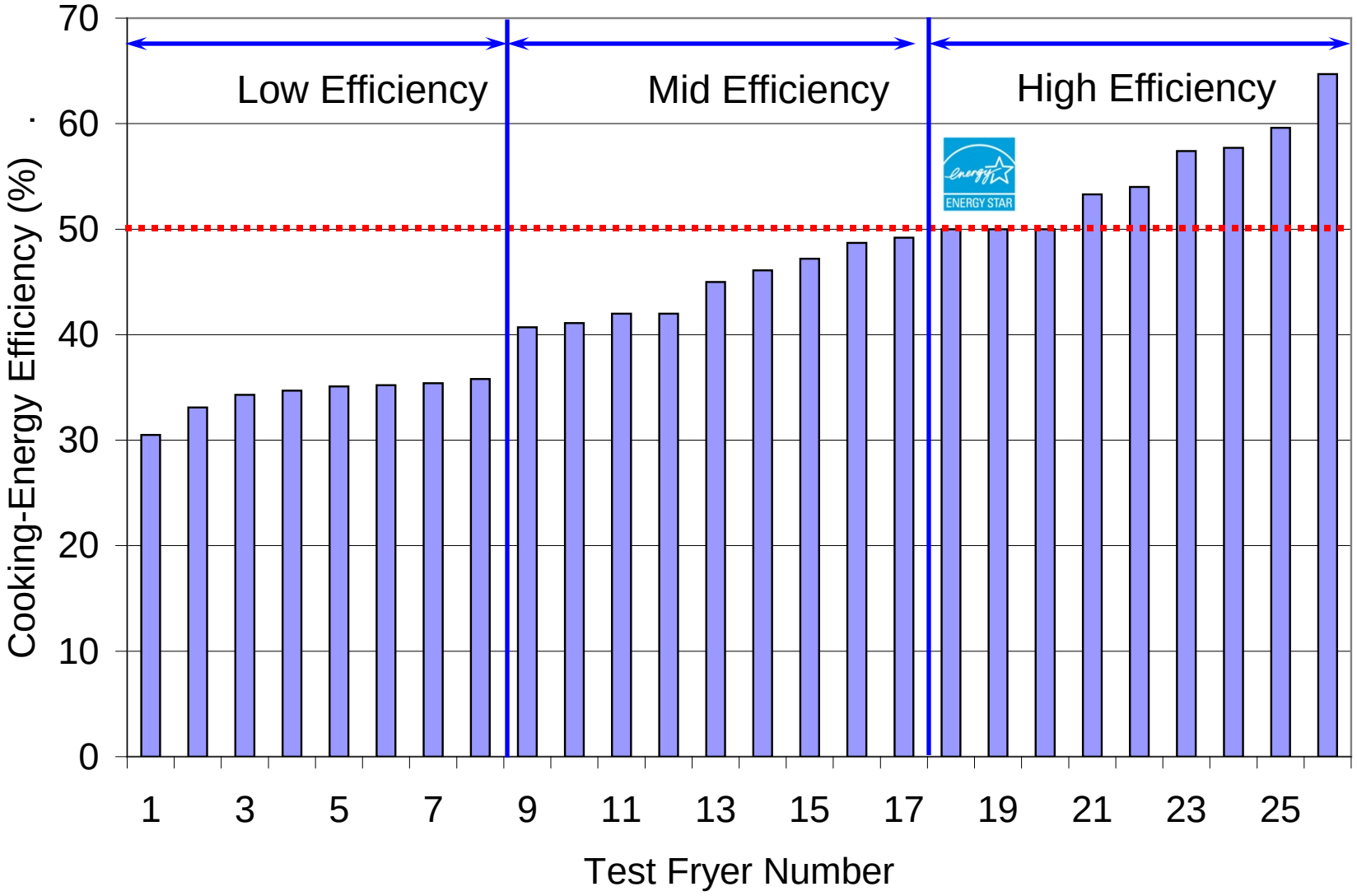
8-Year Life-Cycle Cost
Three-pan Steamer Example



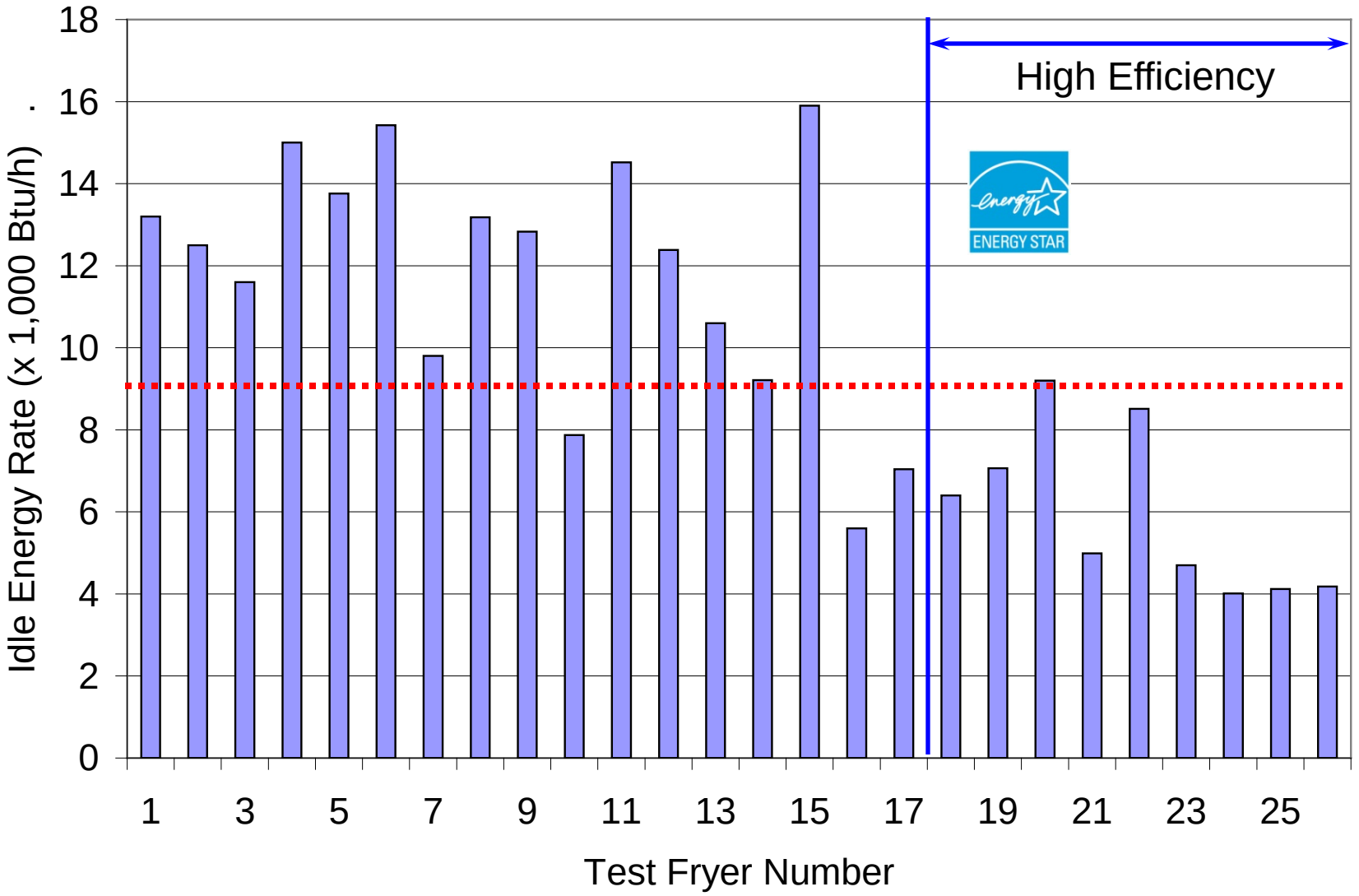
Based on 10¢/kWh and $5 a unit for water

But…is there a compromise in equipment performance?

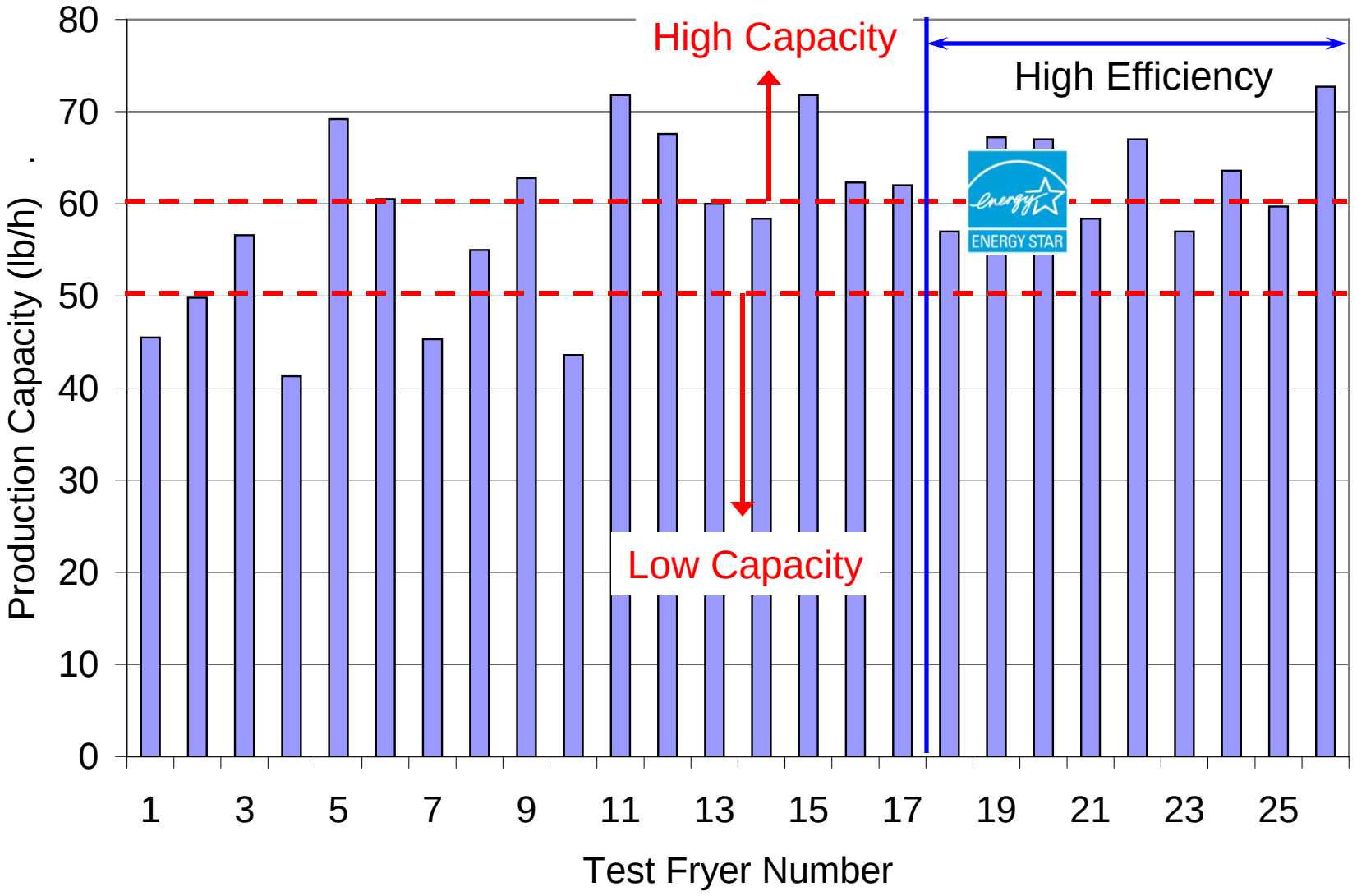
Gas Fryer Efficiency



Gas Fryer Idle Rates

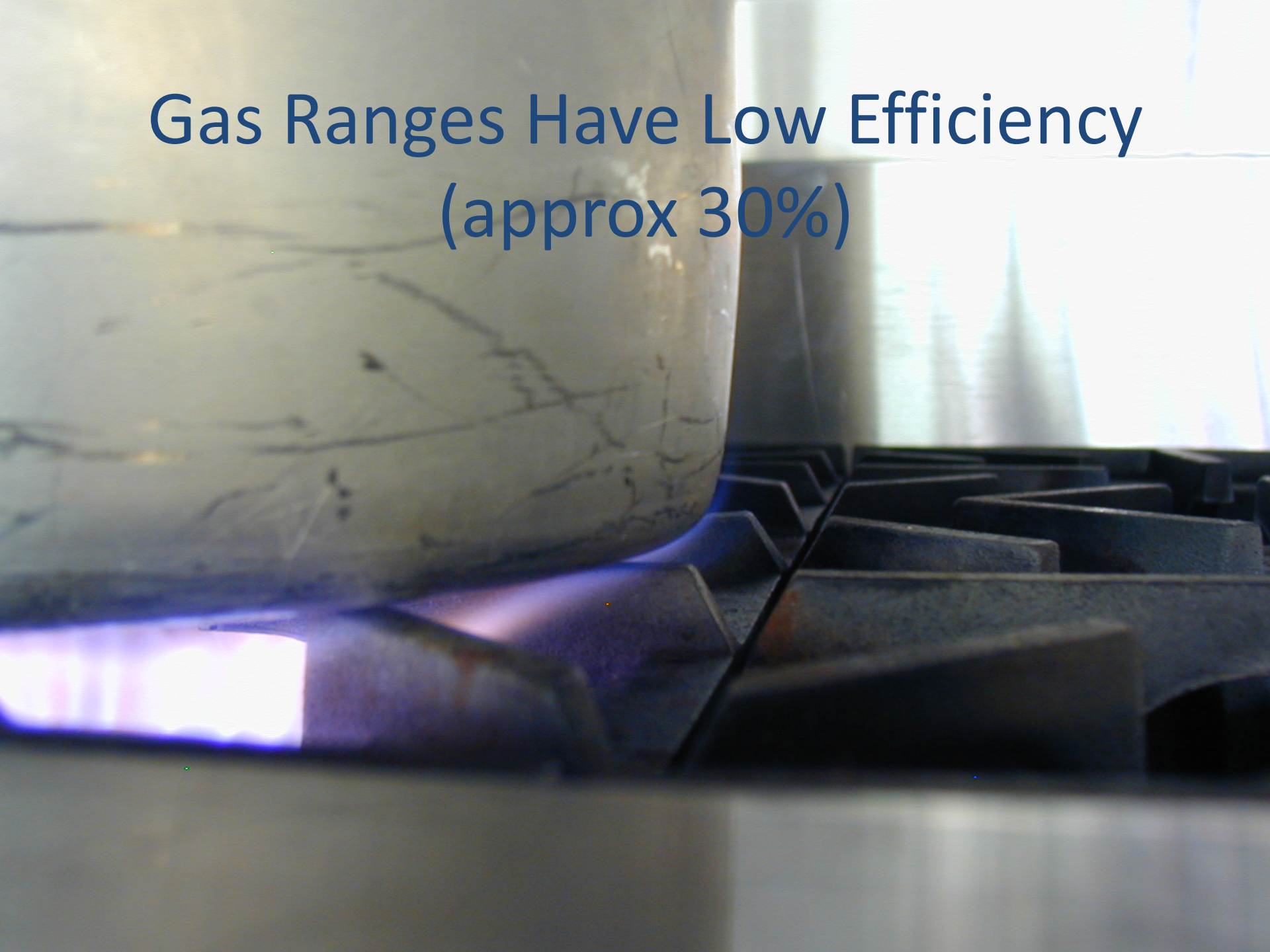


Gas Fryer Production Capacity



High Efficiency = High Performance

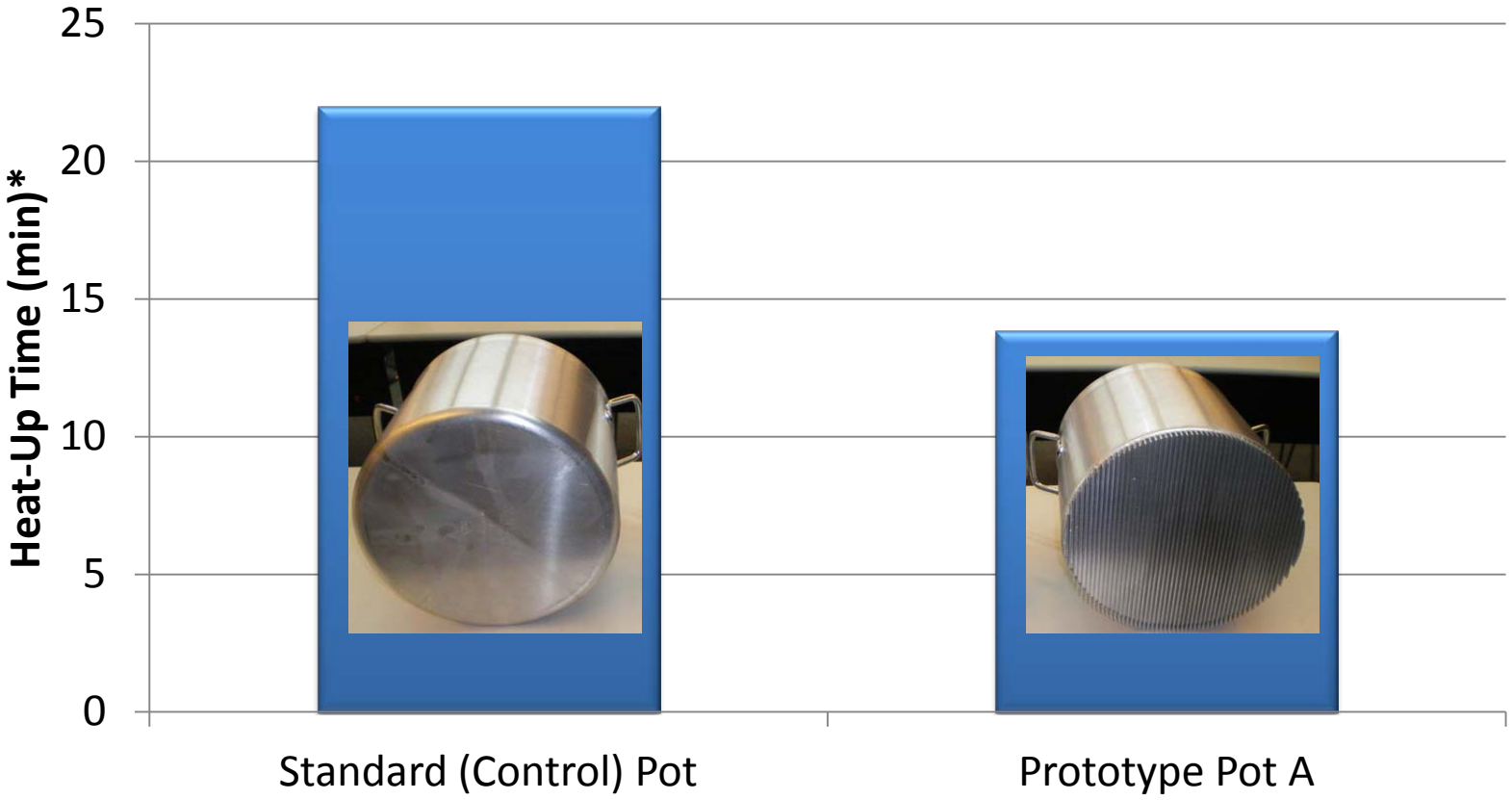
And Now...
Something Really Cool!


Gas Ranges Have Low Efficiency
(approx 30%)

Can the Pot Make a Difference?

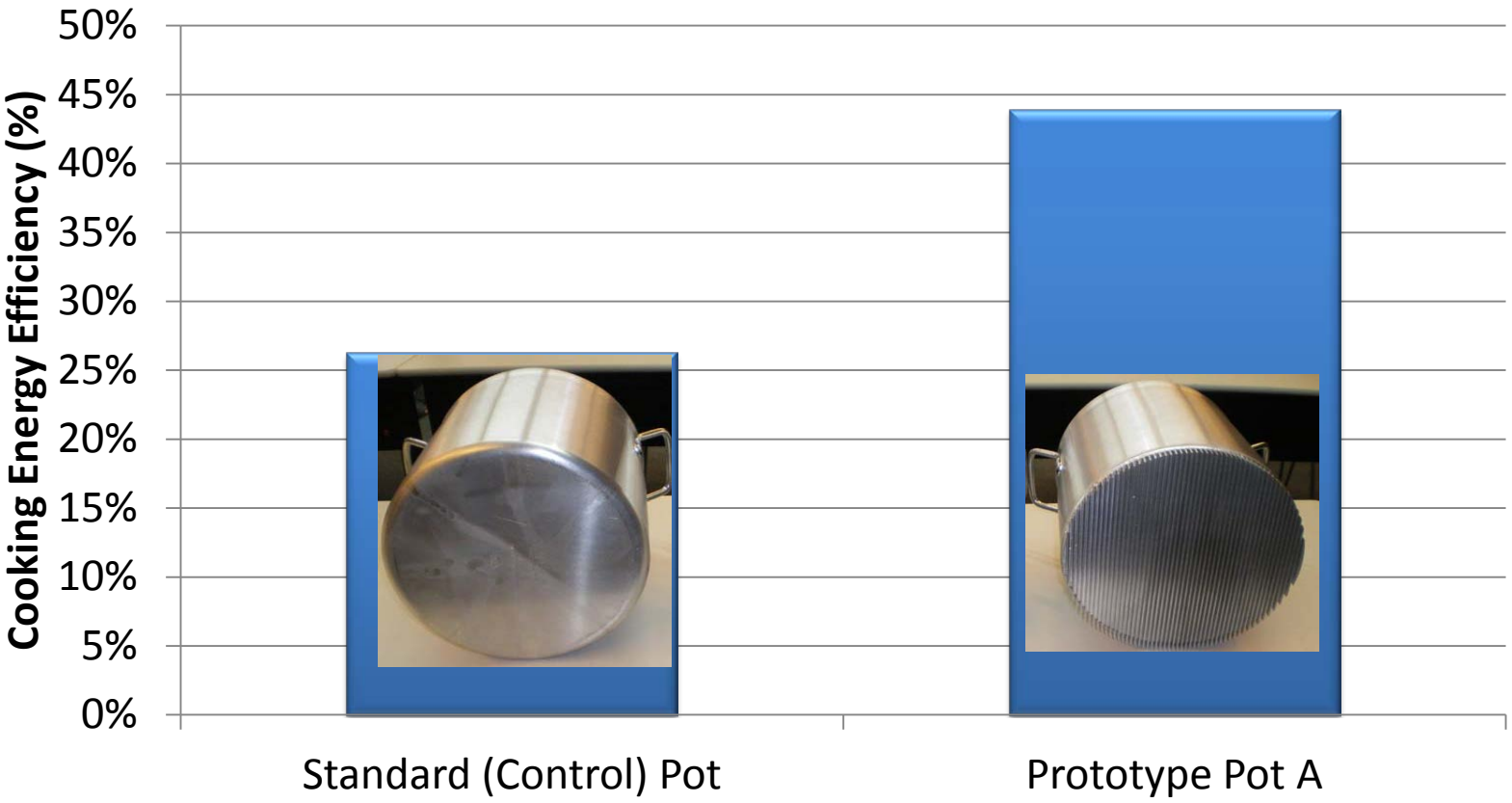
Fins Improve Heat Transfer

Let’s Compare Heat-Up Times*



*Time to heat 20 lb water from 70°F to 200°F per ASTM F1521

Can Range Efficiency Be Improved?



http://www.fishnick.com/publications/appliancereports/ranges/Eneron_Pot_Testing.pdf

…and Hot!

Induction Cooktops

Induction Wok!

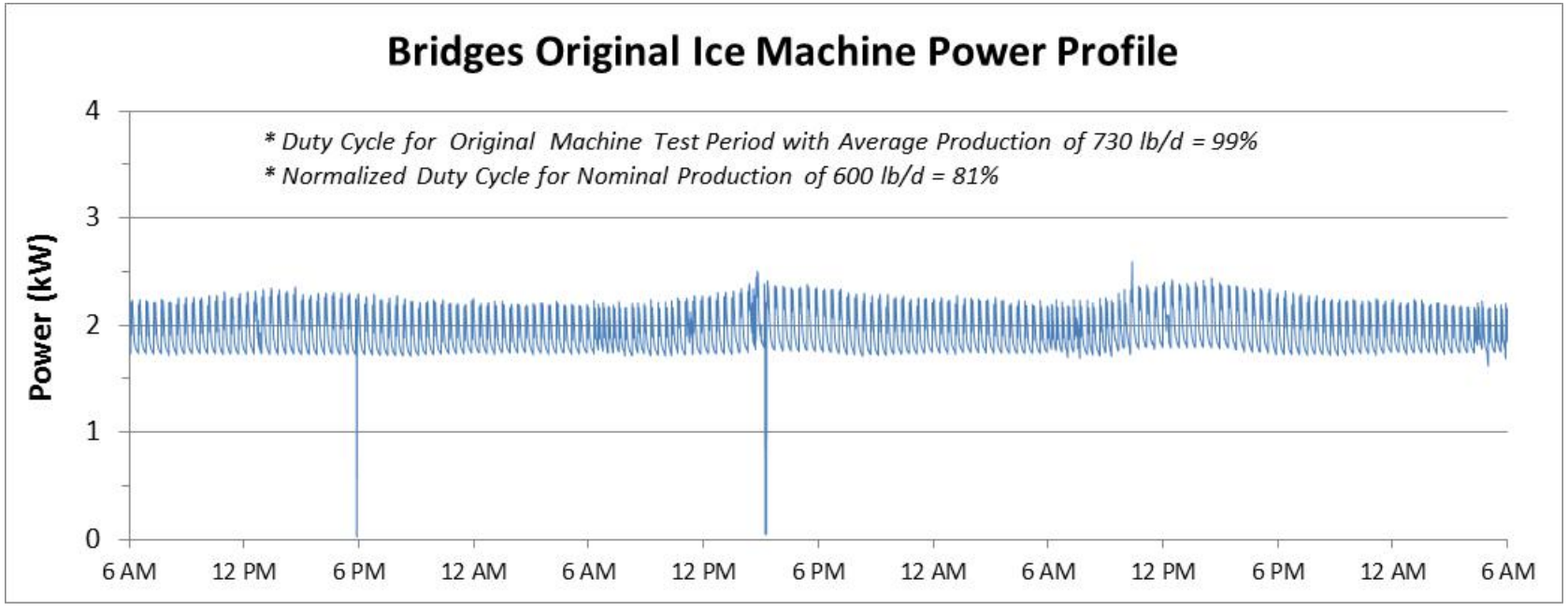
85% plus efficiency and no standby energy!

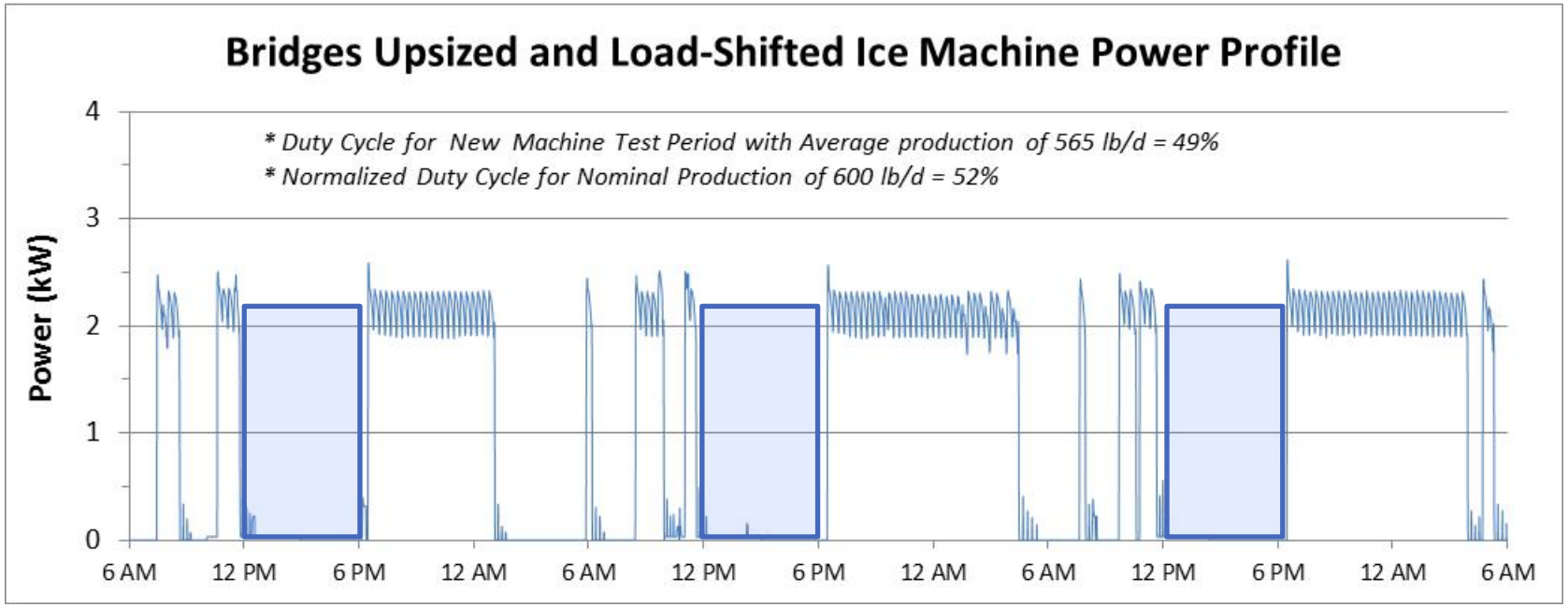
Ice Machines

Candidates for Load Shifting?

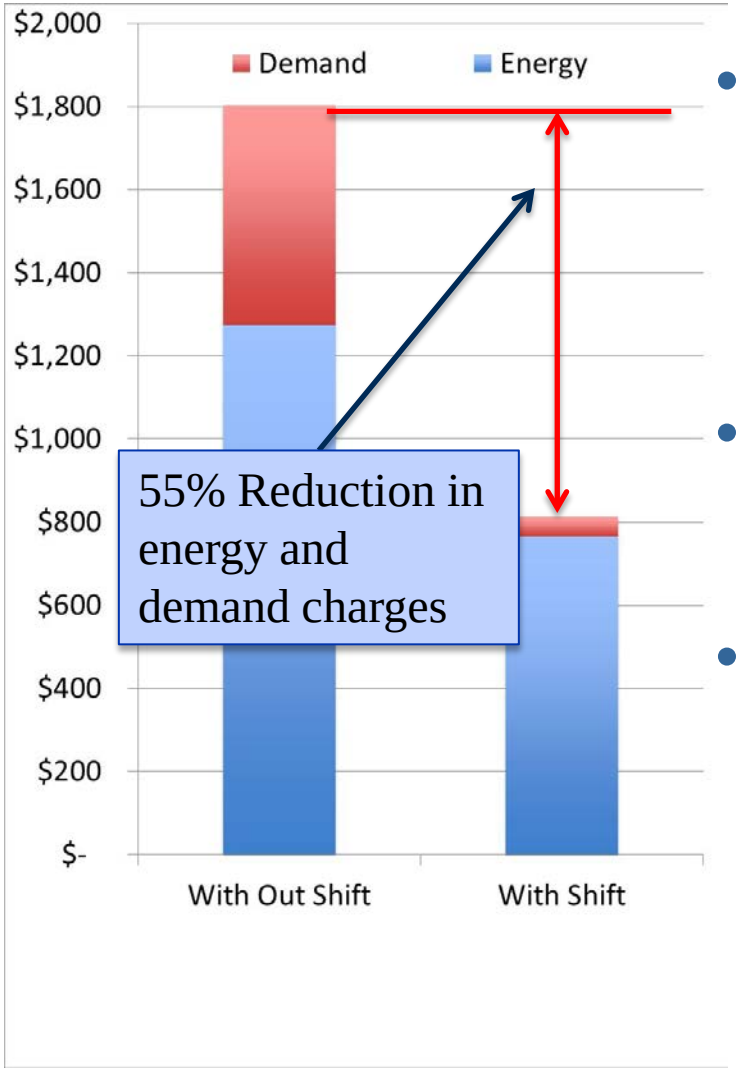
Bridges Restaurant, Danville CA

Ice Machine – Calculated Energy Use		
	Old Ice Machine	New Machine
Rate Capacity (lb/24 h)	751	1,180
Rated Energy Use (kWh/100 lb/ice)	6.6	4.62
Normalized Duty Cycle (%)	81	52
Annual Energy Savings (kWh)	-	4,986
On-Peak Reduction (kW)	-	2.2


Bridges Original Ice Machine Power Profile
* Duty Cycle for Original Machine Test Period with Average Production of 730 lb/d = 99%
* Normalized Duty Cycle for Nominal Production of 600 lb/d = 81%
Power (kW)
4
3
2
1
0
6 AM
12 PM
6 PM
12 AM
6 AM
12 PM
6 PM
12 AM
6 AM
12 PM
6 PM
12 AM
6 AM


Bridges Upsized and Load-Shifted Ice Machine Power Profile
* Duty Cycle for New Machine Test Period with Average production of 565 lb/d = 49%
* Normalized Duty Cycle for Nominal Production of 600 lb/d = 52%
Power (kW)
4
3
2
1
0
6 AM
12 PM
6 PM
12 AM
6 AM
12 PM
6 PM
12 AM
6 AM
12 PM
6 PM
12 AM
6 AM

Cost Savings: Bridges



- By moving the operation of the ice machine to mostly off-peak periods the energy cost savings would be $508.
- The Demand Charge savings would be an additional $481.
- Using a simple time clock to delay the operation of the ice machine this restaurant would see an annual savings of $989.

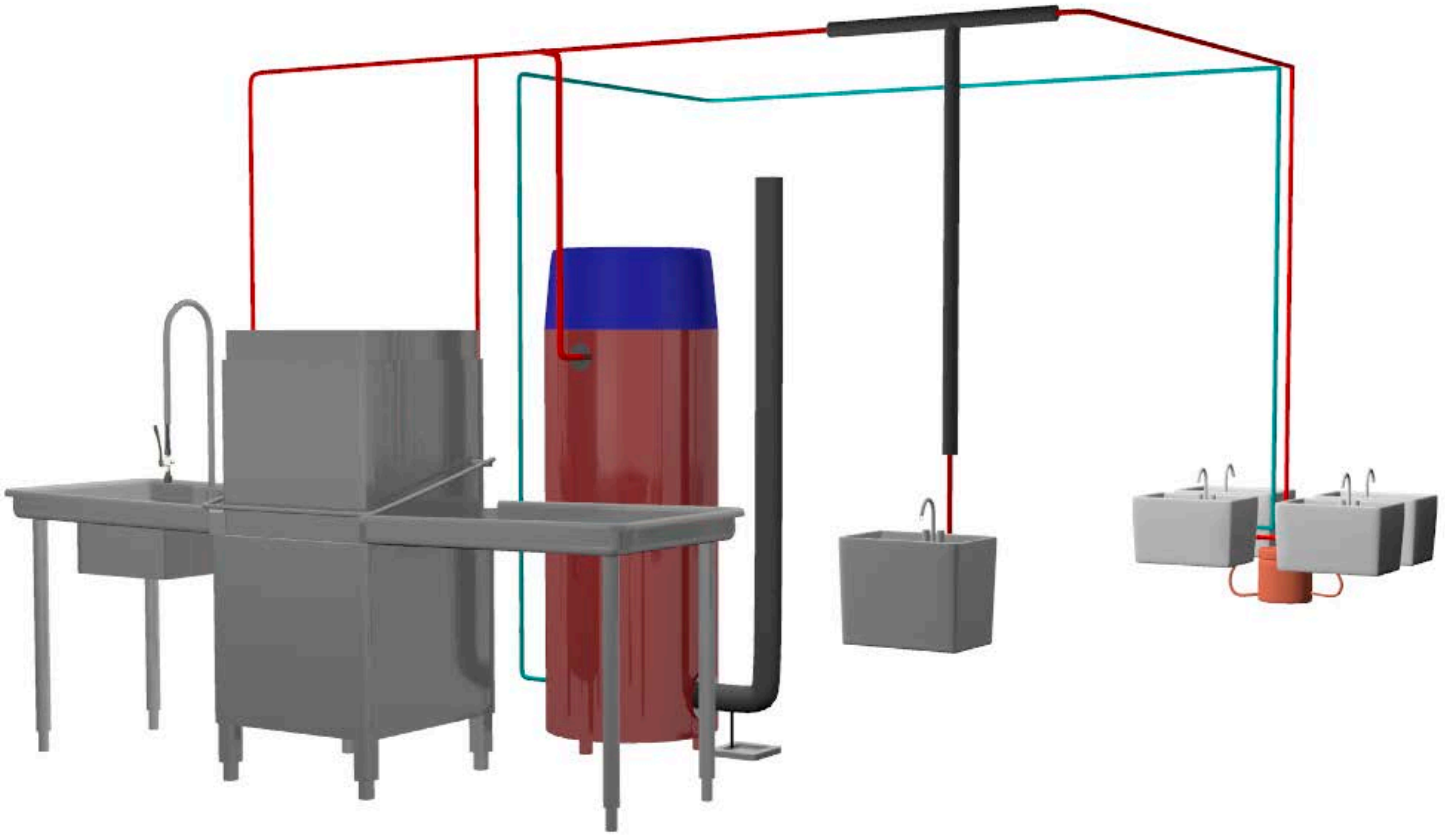
Evaporator Fan Motors

Install high-efficiency electronically commutated motors (ECM)

Example:
Low efficiency motor draws 135 watts
ECM motor draws only 44 watts
Save 91 watts or $120 dollars a year of fan energy
Save $60 to $120 dollars a year of compressor energy
Motor costs about $150
Payback is less than one year!

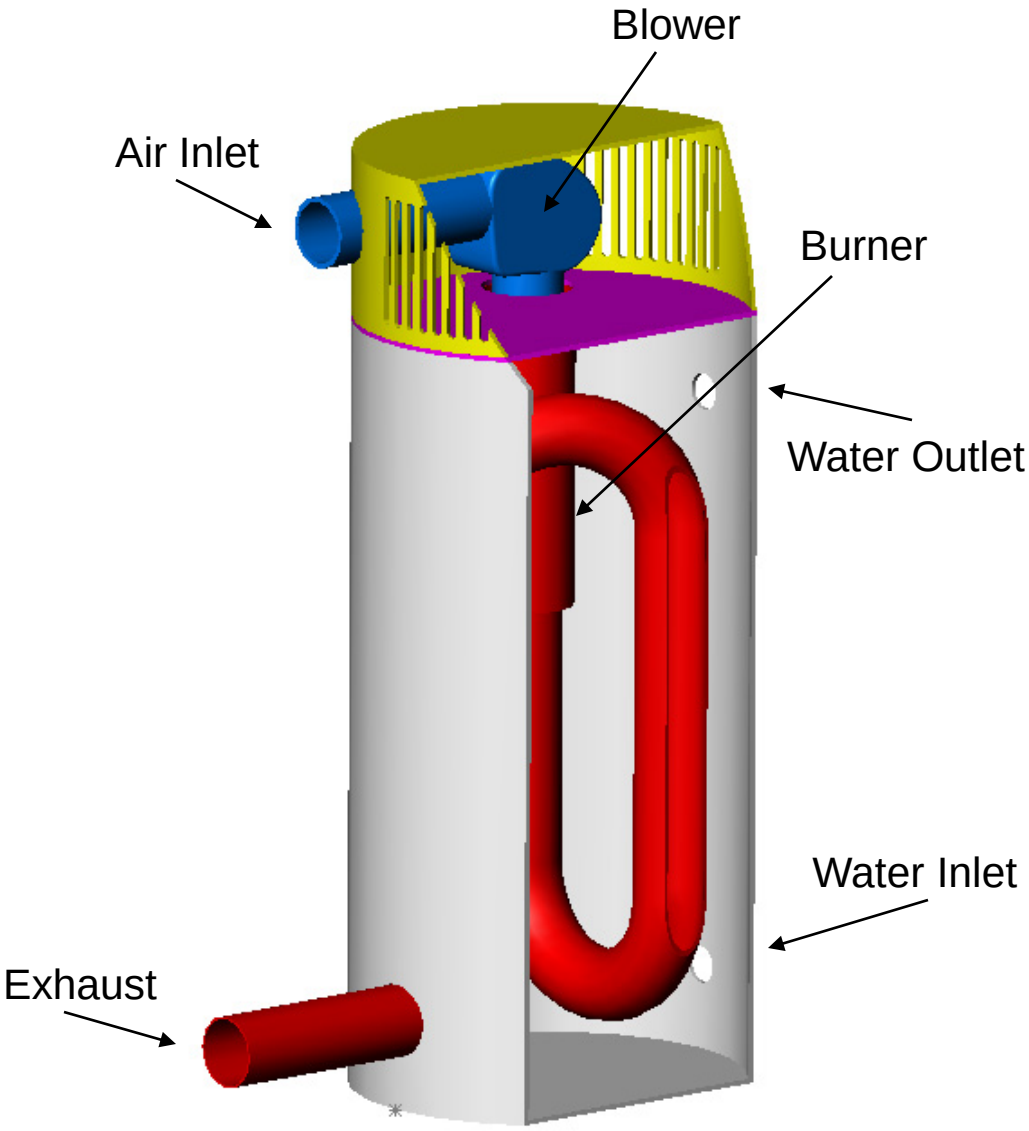
Operating cost based on an electric utility rate of $0.13/kWh

Leveraging Energy and Water Savings in Hot Water



http://www.fishnick.com/design/waterheating/Water_Heating_Design_Guide_Final.pdf

High Efficiency (Condensing) Water Heater



High Efficiency

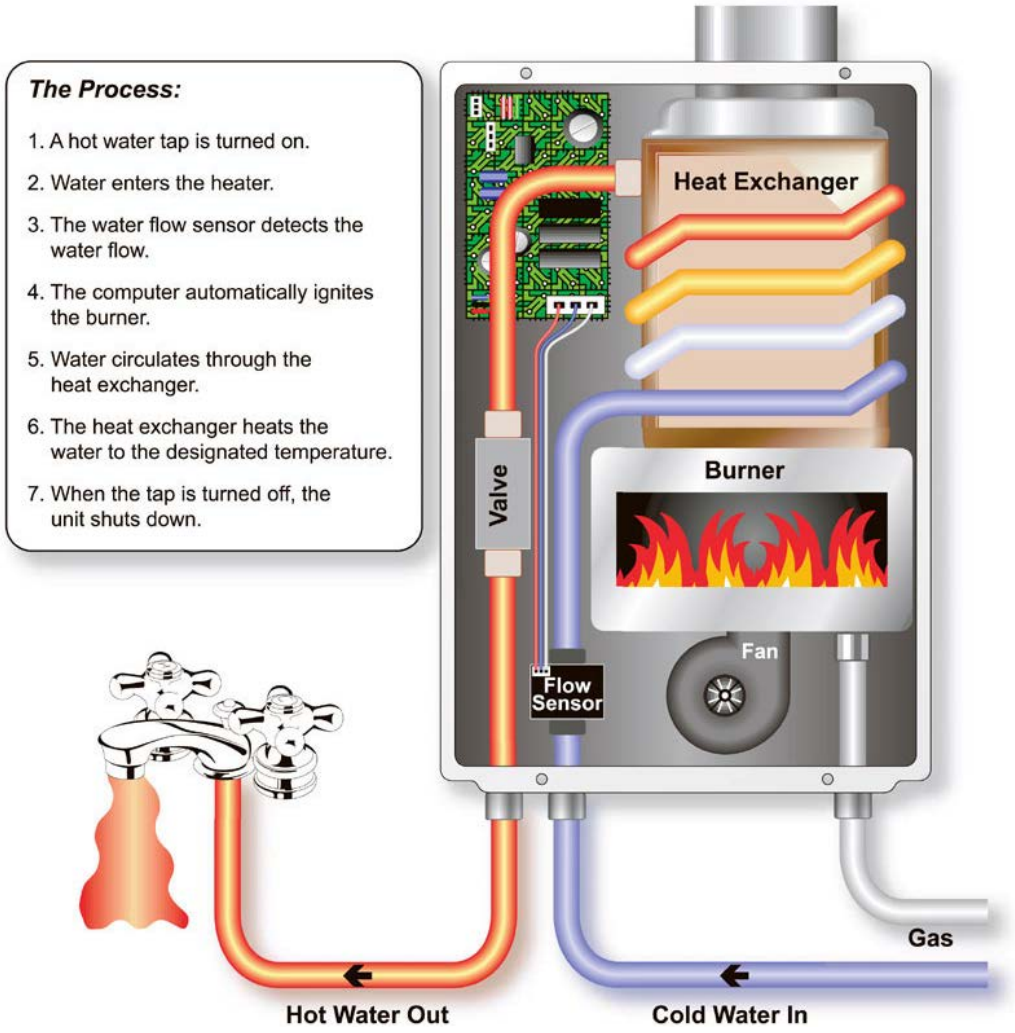
Pros

- condensing
- 95%$^{+}$ efficiency
- Standby loss: 600 – 1000 Btu/h
- potential lower cost installation

Cons

- condensing
- more complex
- not the standard
- potential for repair delay
- higher first cost

Tankless (Instantaneous)



Takagi Industrial Co. USA Inc.

Tankless

Pros

- smaller footprint
- outside installation possible (some climates)
- no standby loss

Cons

- 80 - 84% thermal efficiency
- low-flow limits
- may need multiple units
- special installation required (stainless venting)
- maintenance may be higher

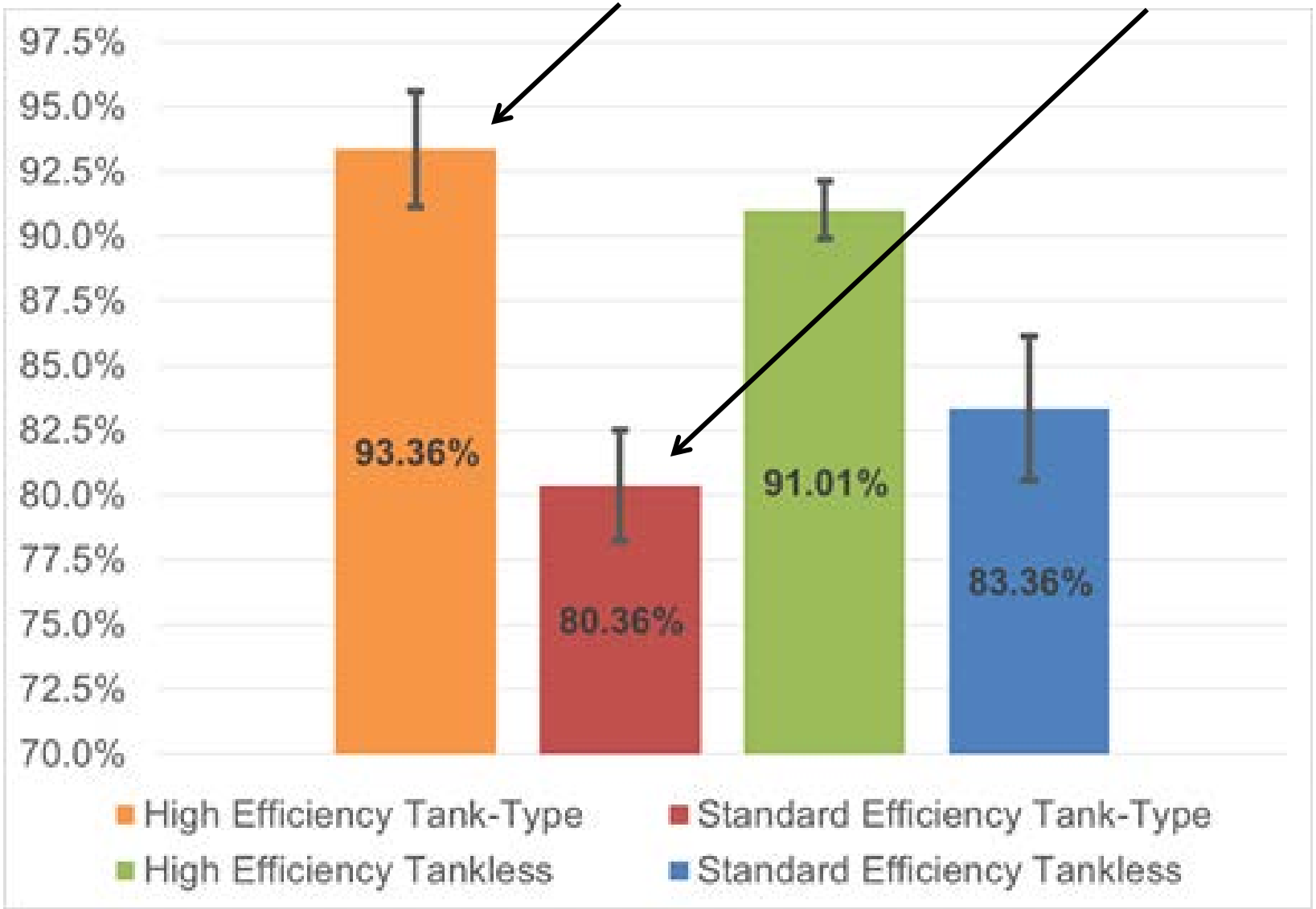
High efficiency condensing models (>94%) are now available in North America!

PIER Funding for Research at PG&E Applied Technology Services

PG&E Commercial Water Heating Lab

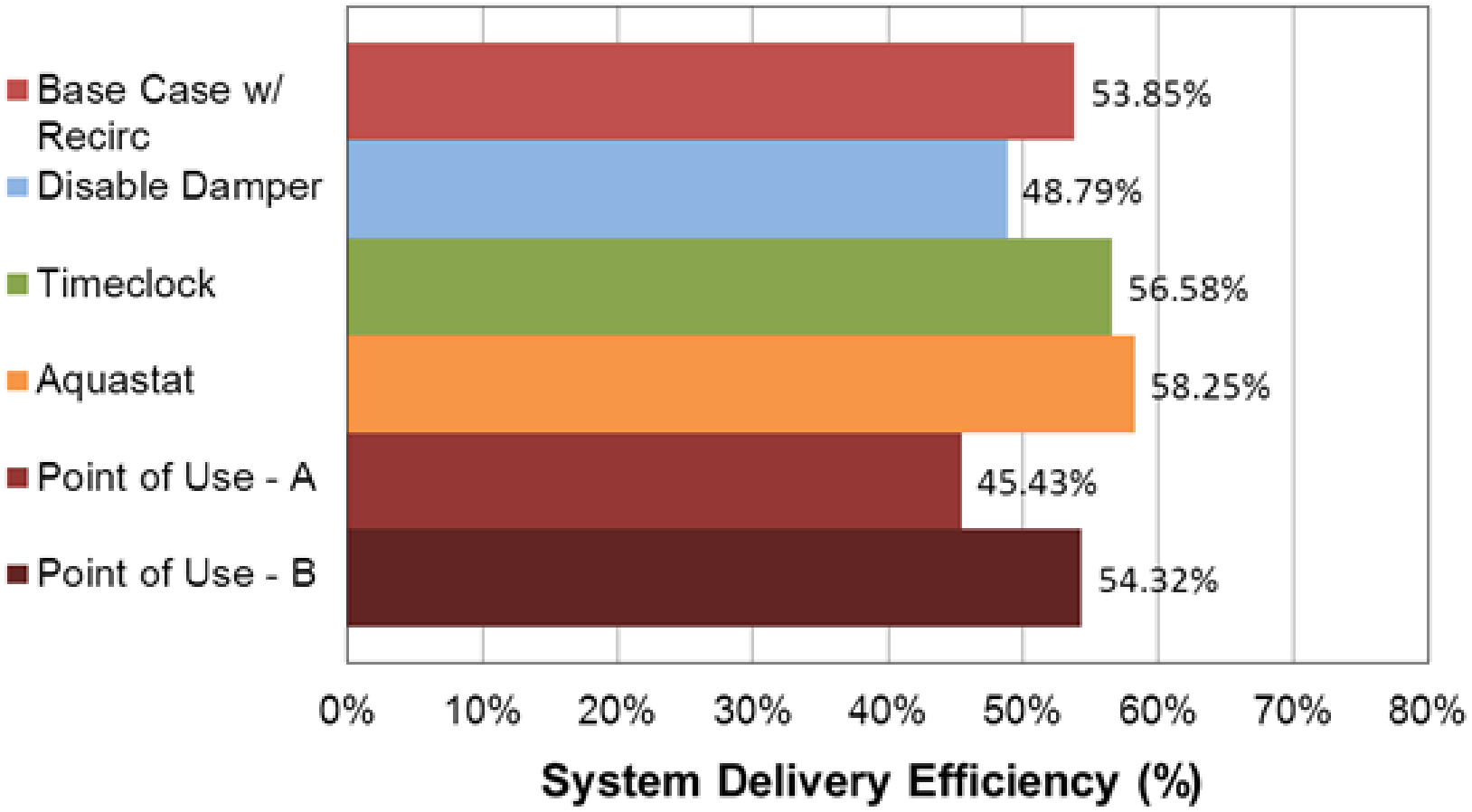
ANSI TE Test at PG&E ATS Lab

Standby loss of HE tank is 670 Btu/h versus SE tank at 1650 Btu/h



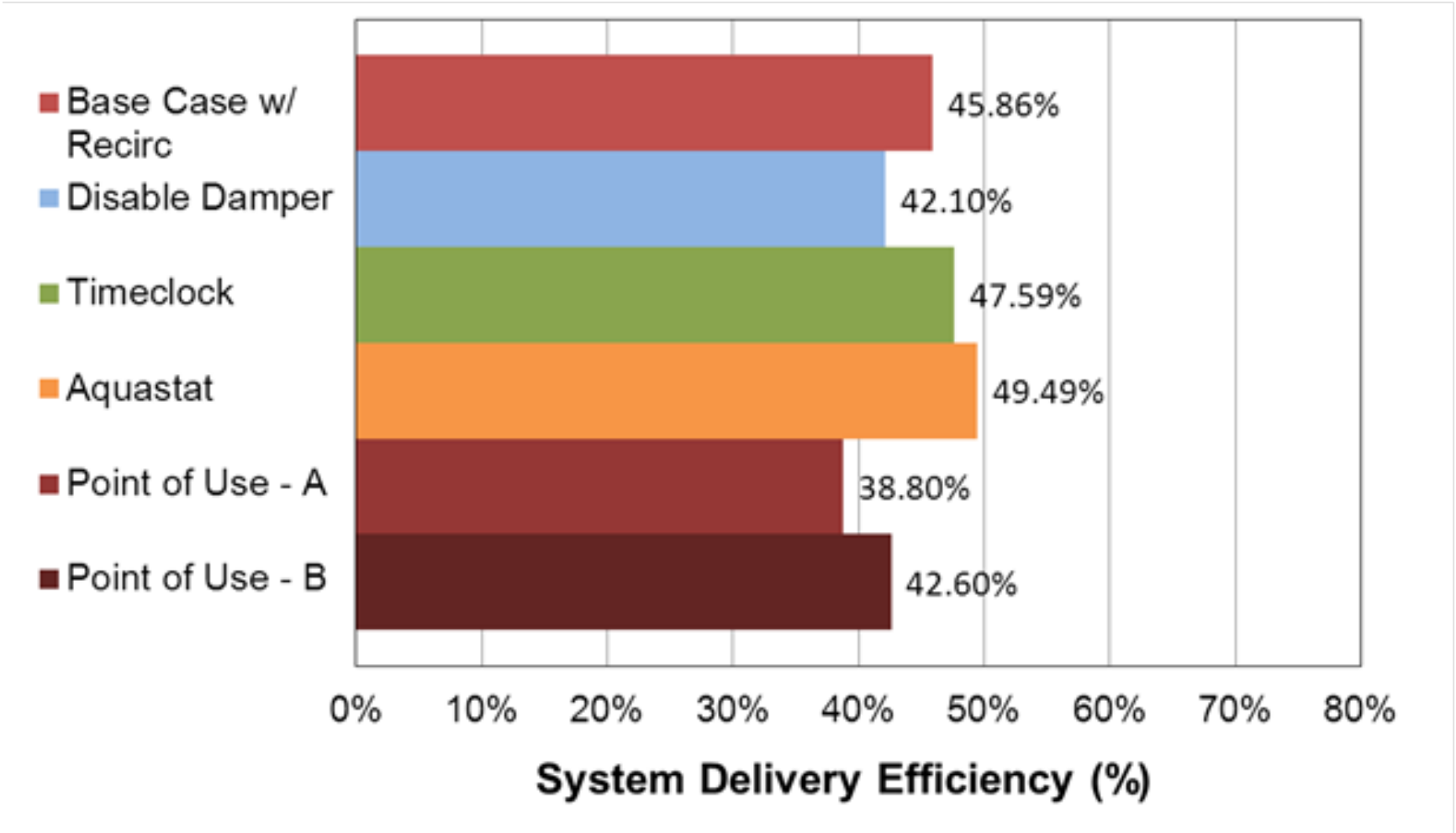
Retro-Commissioning Results from ATS Lab

System delivery efficiency of a distribution system with 1”-thick insulation



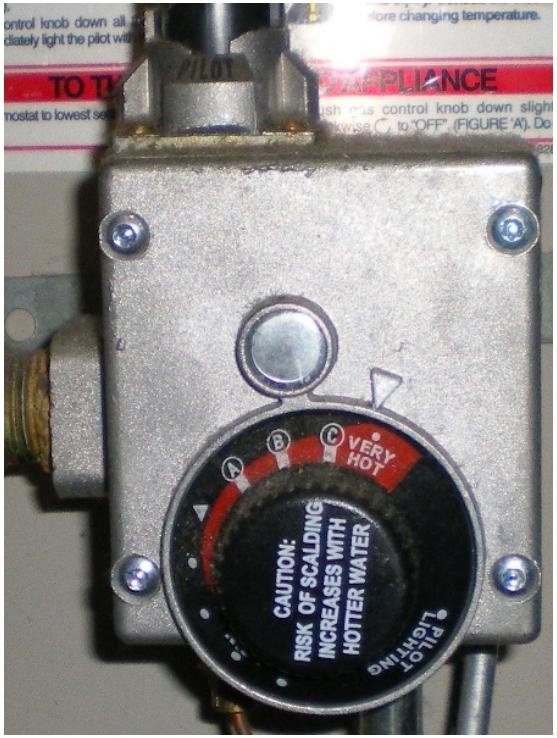
Retro-Commissioning Results from ATS Lab

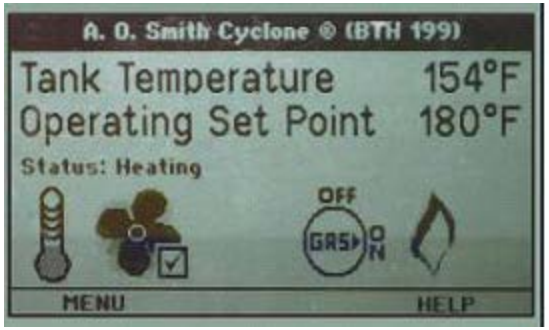
System delivery efficiency of a non-insulated distribution system dropped by 9%!

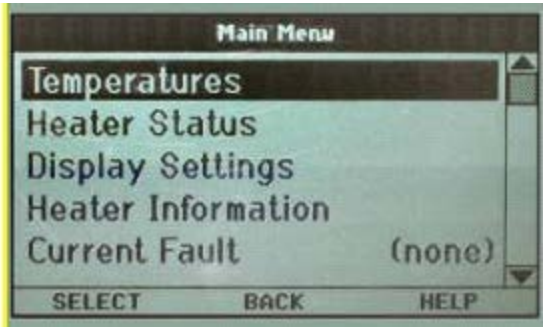


Intelligent Water Heaters?

- Easy to read and accurate thermostats are needed
- Condensing water heaters with central processing units





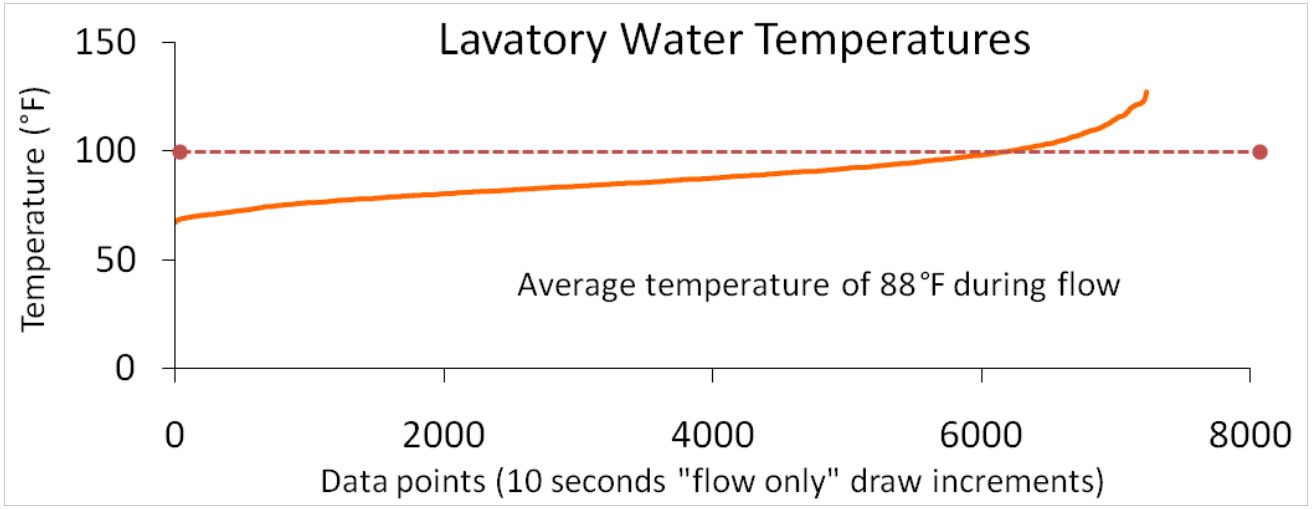


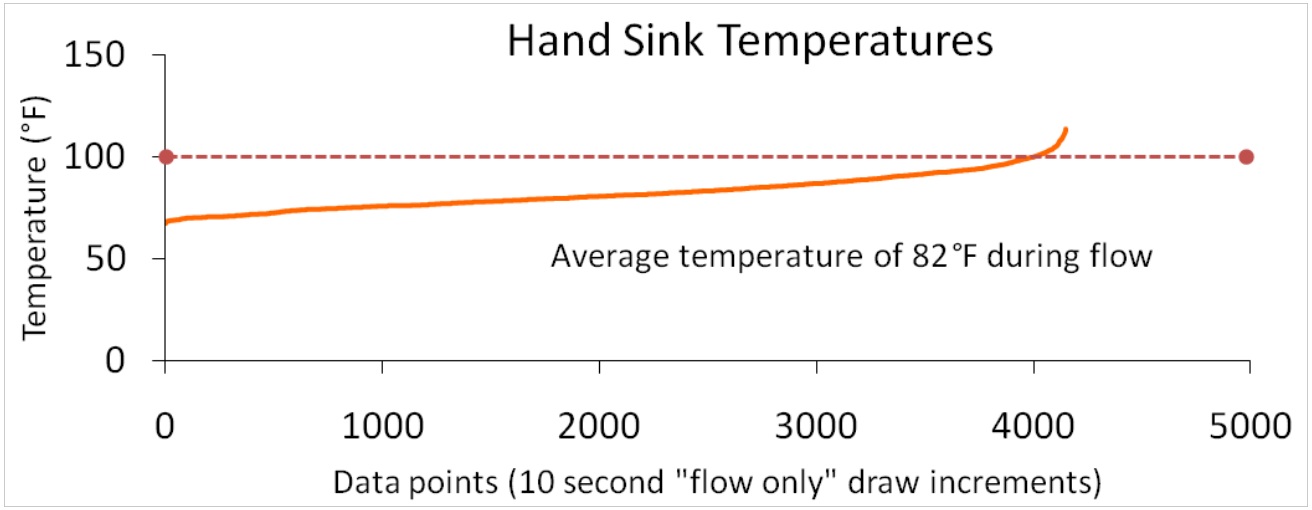
Hand Sink Delivery Problems from a High-Foot-Traffic Facility with no Recirculation

- 1-month data set
- Recorded 10-sec data intervals
- Filtered only for flow periods
- Sorted by temperature
- Temp. deemed satisfactory for hand washing if >100°F

<u>Results of testing</u>

100°F water reached the **lavatory 14% of the total draw time** and the staff **hand sink only 3% of the total draw time**





One Solution: Distributed Generation

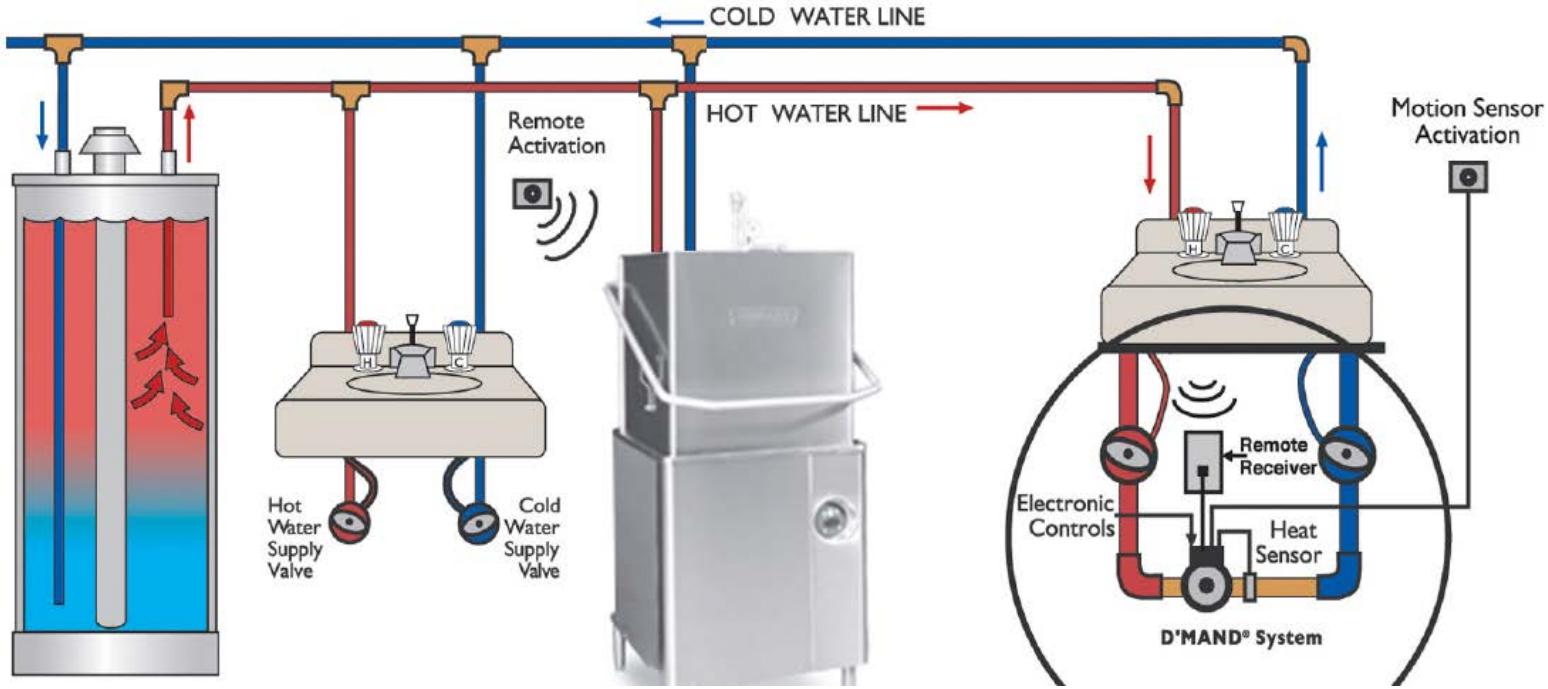
- A hybrid system that is a combination of *electric tankless heaters* at remote hand sinks and a *simple distribution system in the kitchen fed by a water heater placed centrally*

- Benefits: works well with low flow aerators, saves energy and increases hot water delivery performance

Another Solution: Demand Circulation

The task of demand circulation is to circulate hot water in the supply line and down to specified fixtures on demand and de-activate automatically when hot water has reached its target.

Demand circulation saves energy and improves hot water delivery.



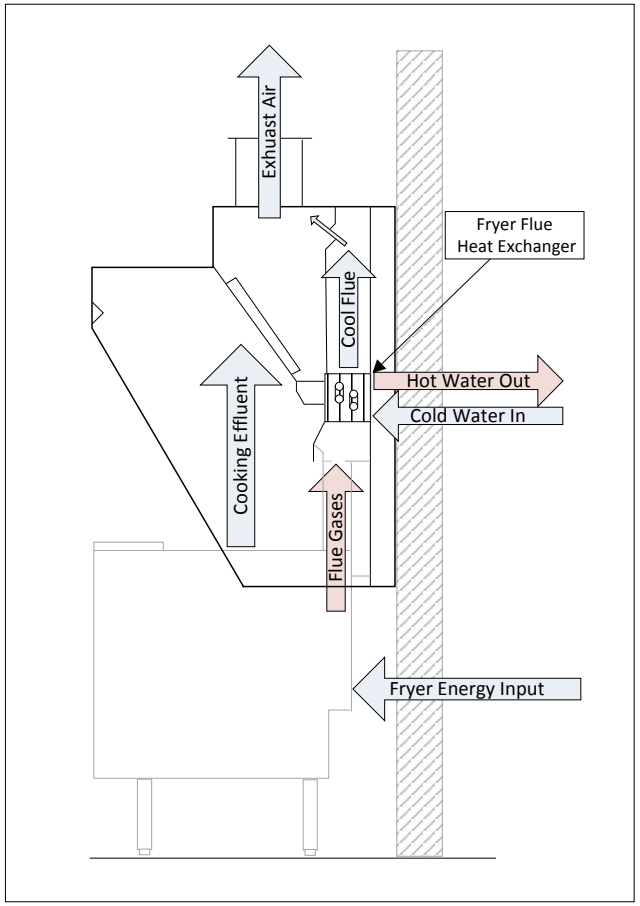
Hot Water Systems of Tomorrow

Will move towards net zero-energy water heating.

Heat recovery and renewable energy technologies will become the primary water heaters.


Heat Recovery Potential?

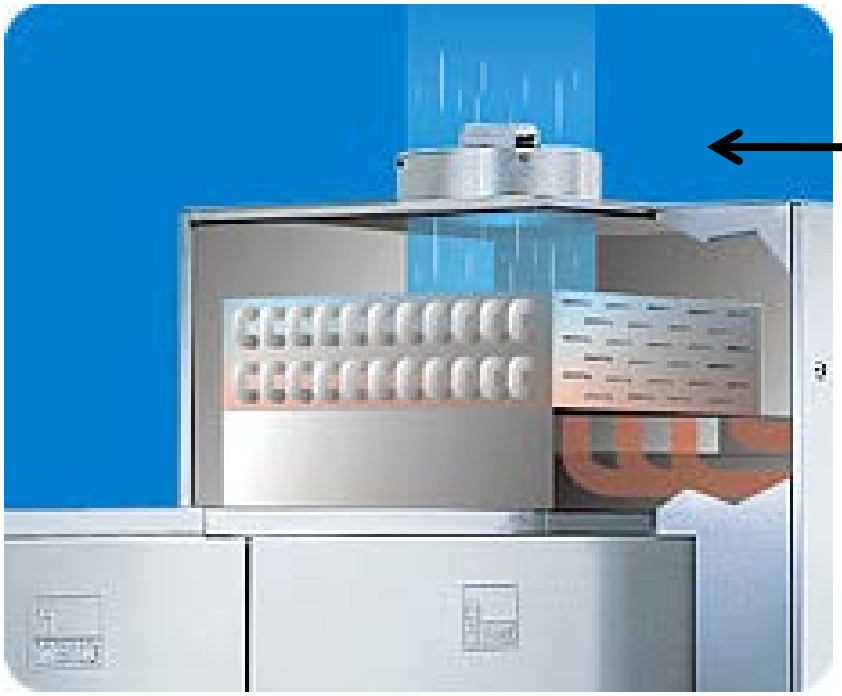
Flue Gas Heat Recovery



Dishmachine with Integrated Heat Recovery

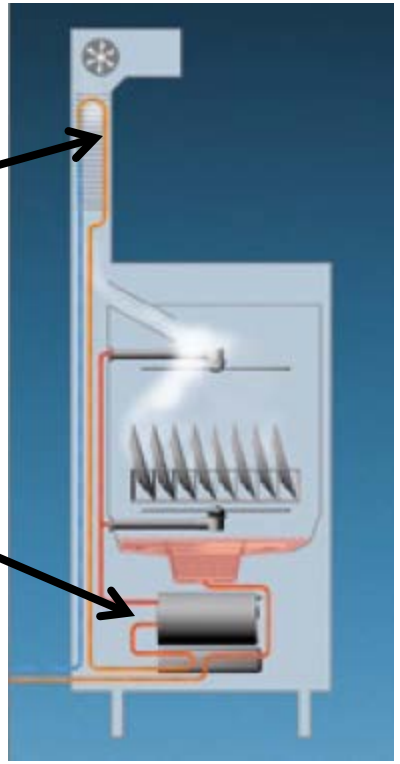
Conveyor: HOBART, MEIKO, Electrolux, Champion

Door Type: HOBART, winterhalter



Waste Air HR

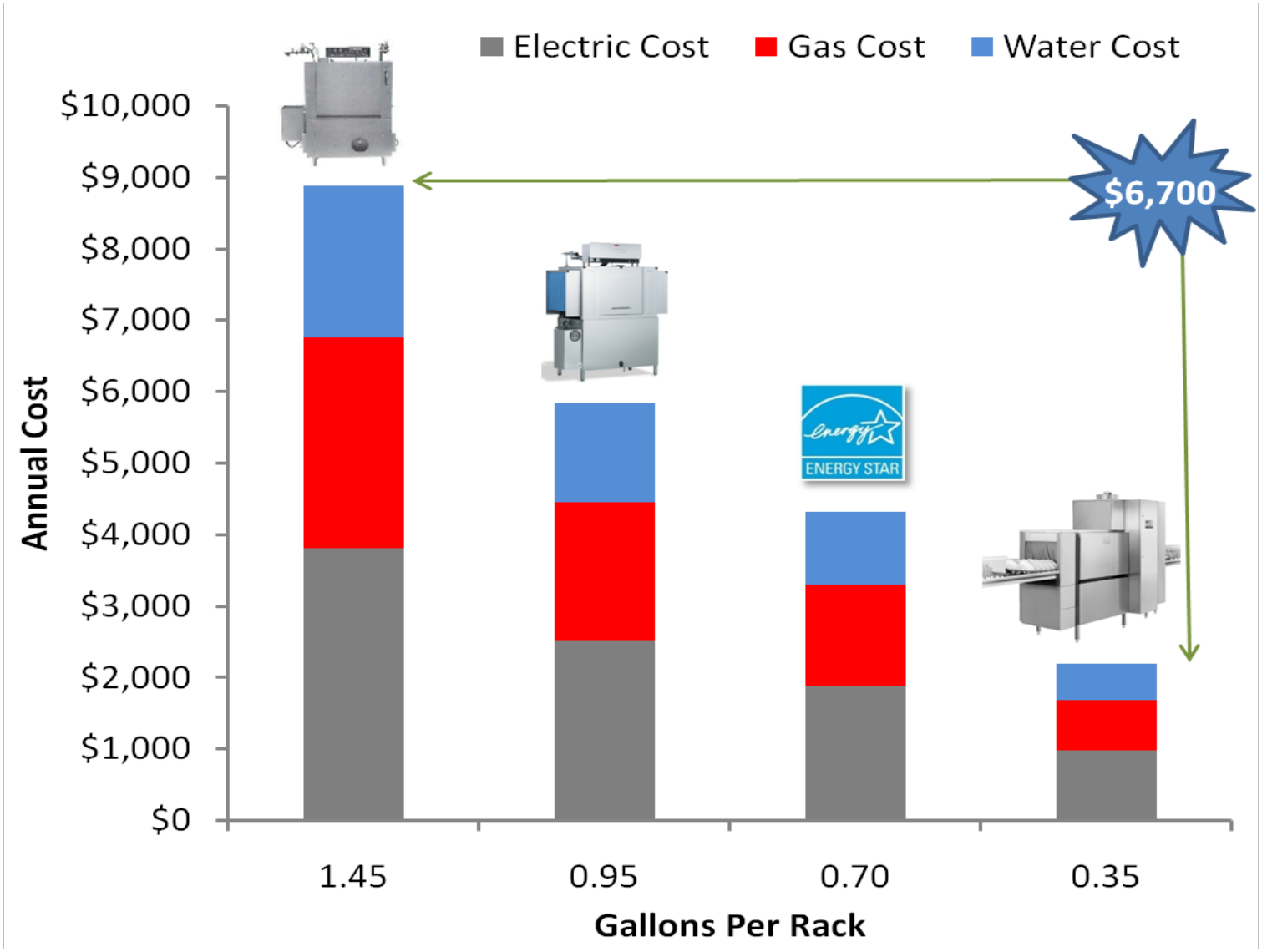
Drain Water HR



Advantages of Units with Heat Recovery

- Some models operate on the cold water line only for wash tank fill and operation!
- Potential to reduce the size of the water heater.
- Potential to reduce the length and diameter of the distribution system.
- Potential to eliminate the need for recirculation, no longer necessary to get 140°F water to the dishwasher (with cold-water only unit).
- Potential to drop heater thermostat by 20°F, saving energy.

Operating Cost Comparison



KITCHEN INNOVATIONS 2014 AWARD
NATIONAL RESTAURANT ASSOCIATION RESTAURANT, HOTEL-MOTEL SHOW

NVX2060 Dishwasher Heat Exchanger
NRA Kitchen Innovations 2014 Award

Novothermic's NVX2060 Dishwasher Heat Exchanger has just been selected among the recipients of the National Restaurant Association's Kitchen Innovation Awards 2014, which recognizes cutting-edge advancements in kitchen equipment for the food service industry.

EXCHANGER NVX-2060

A custom-made heat exchanger for your dishwasher

- Patented, double-wall heat exchanger
- Certified performance providing up to 50% recovery
- Display screen showing savings, equipped with a touch interface
- Made of stainless steel
- Electronic control unit

Download the technical specifications

Download the warranty

Solar Preheating

- More cost effective than solar water heating (where the system is designed for a high solar fraction).
- Lower cost collectors, less solar storage capacity

Heat Rejected from Refrigeration

Refrigerant [De-superheater] Heat Recovery?

Therma-Stor

Mueller Fre-Heater

Commercial Heat Pump Water Heaters

- High efficiency with typical COP 4 with ambient temp of 80°F in kitchen
- 1 unit of energy in = 4 units of heat out for water heating + 3 units of space cooling
- Capable of reducing cost of running an electric resistance heater by up to 75%
- Great way to reduce humidity in the sanitation area or capture waste heat from the cooking area in the kitchen
- Unit can provide spot cooling in the kitchen and heat hot water to up to 140°F

Regulate Dipper Wells

Typical Flow Rate:

- 0.13 gpm
- 51,246 gal/yr
- water/sewer: $340

Coffee Chain removes a water waster!

Designing Energy Efficiency into Commercial Kitchen Ventilation!

The Design Challenge!

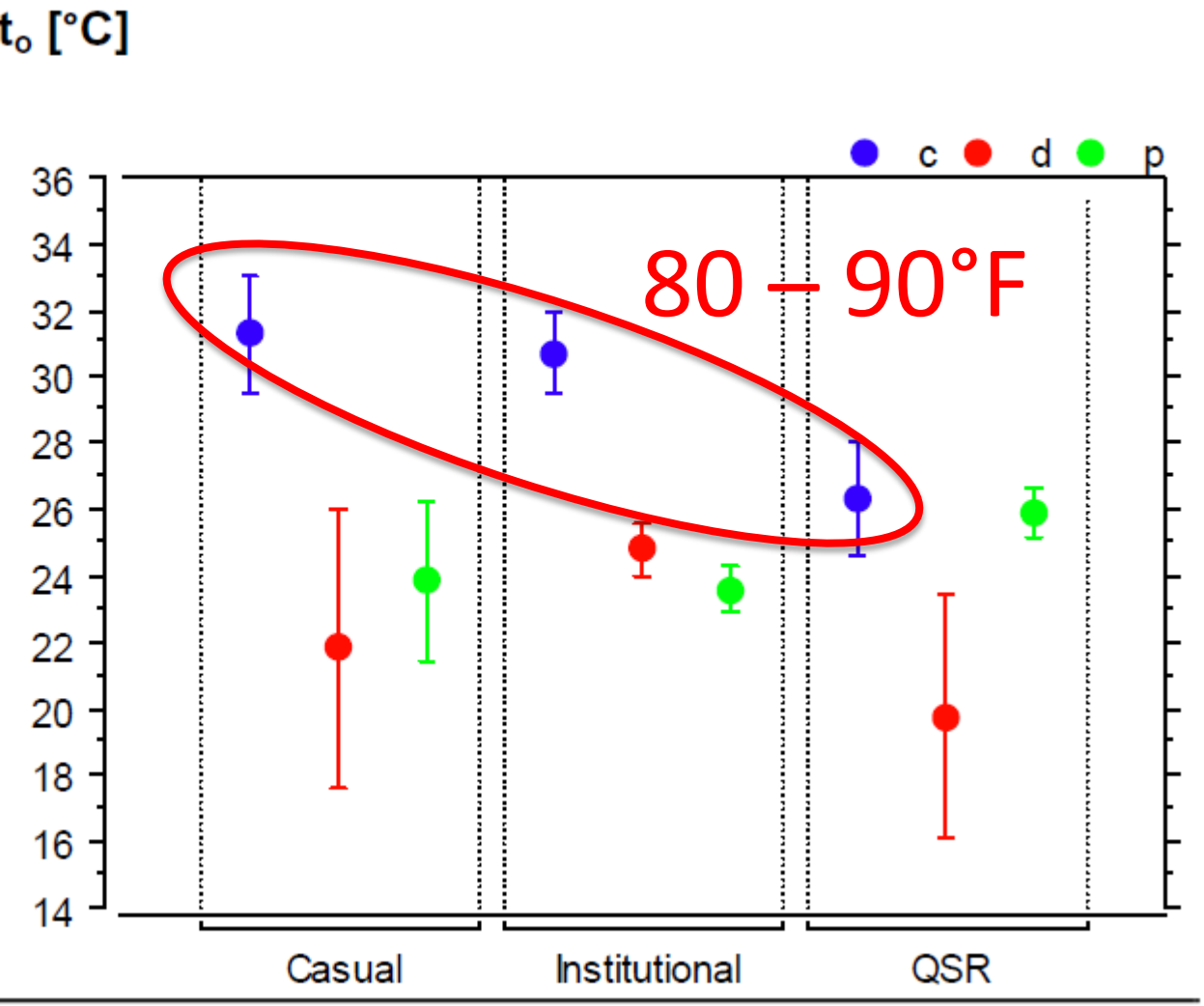
There is no piece of equipment in the commercial kitchen that generates more controversy that the exhaust hood!

ASHRAE RP-1469 – Thermal Comfort in Commercial Kitchens

Final Report 01.06.12

Average of Operative Temperature for Kitchen Type and Kitchen Zones with 95% confidence interval (100 kitchens)

t_o [°C]	t_o [°F]
36	97
34	93
32	90
30	86
28	82
26	79
24	75
22	72
20	68
18	64
16	61
14	57



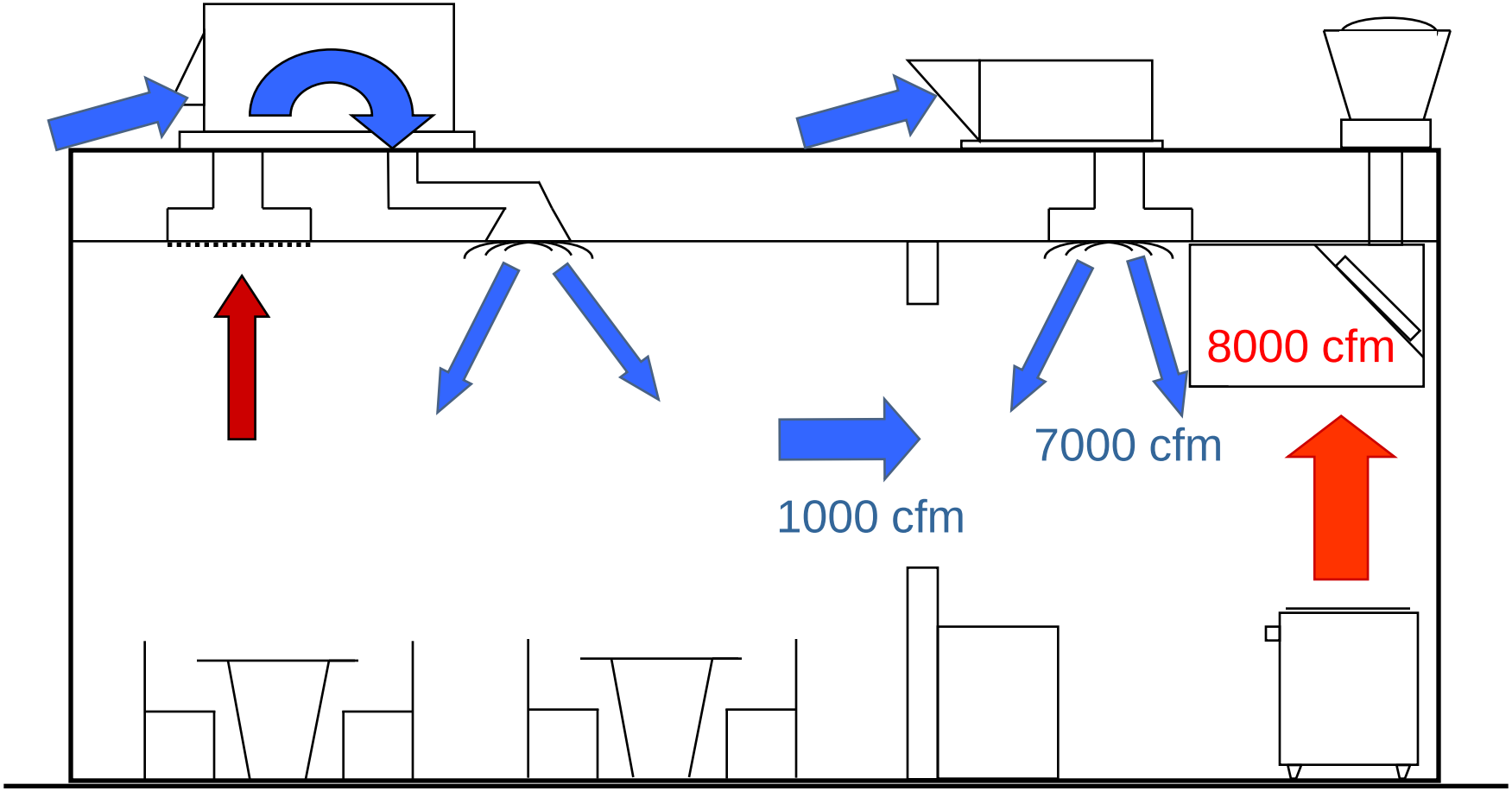
Note: “c” is Cooking, “p” is Preparation, and “d” is Dishwashing zone.

Will integrated CKV-HVAC Design improve thermal comfort?

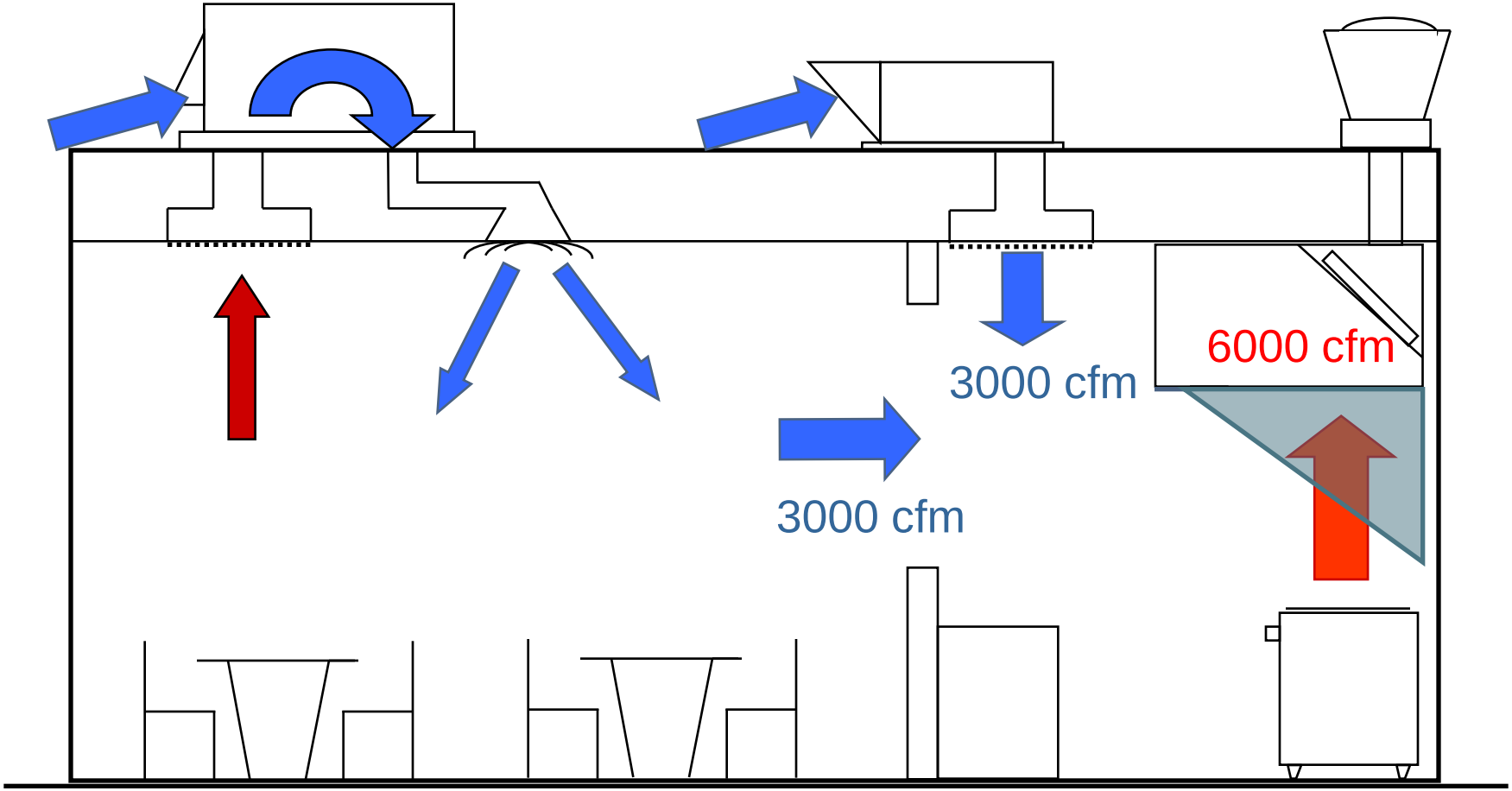
And what does CKV-HVAC integration really mean?

Conversely, what does NOT integrating CKV with HVAC mean?

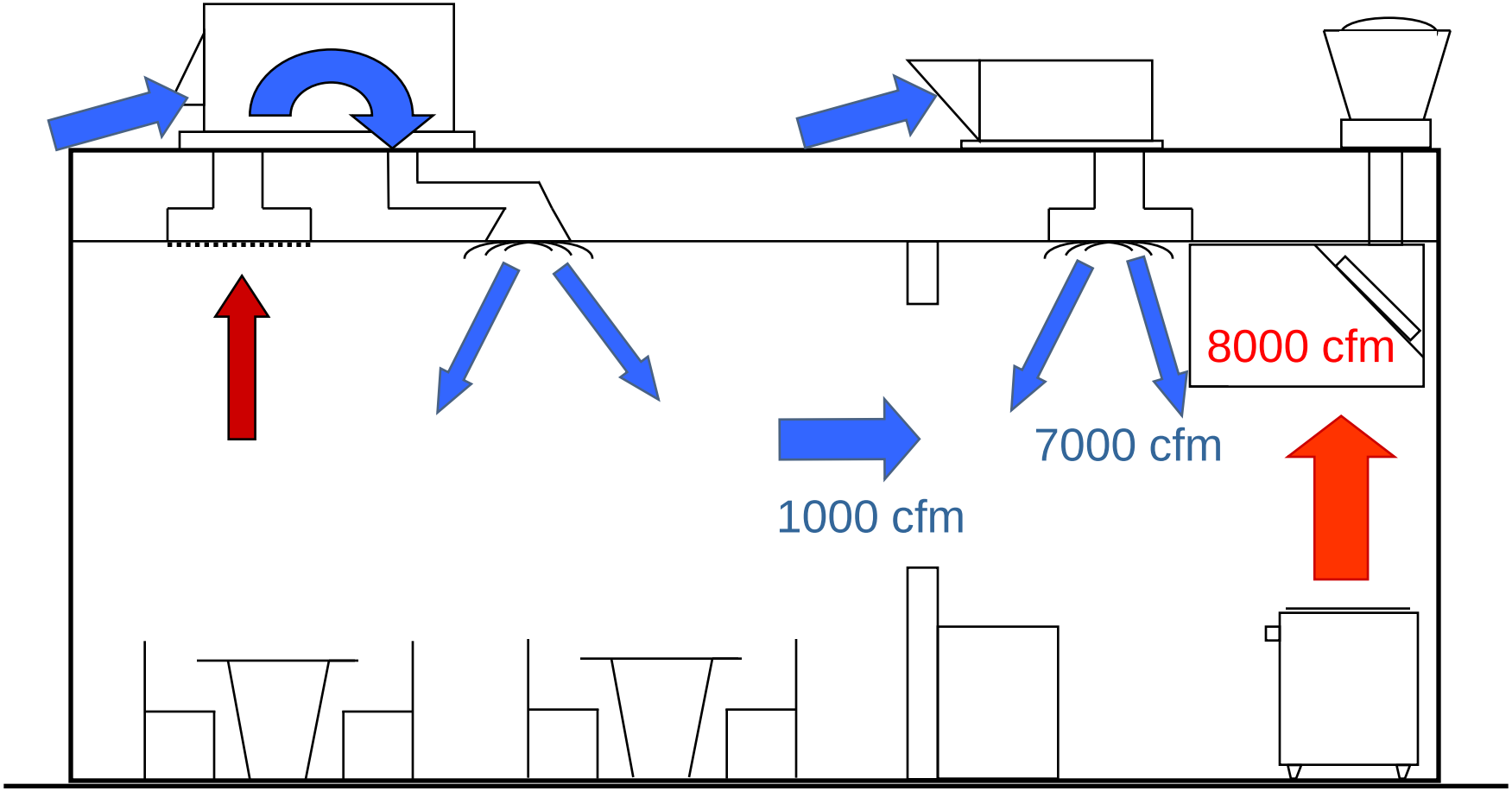
Non-integrated design



Integrated design

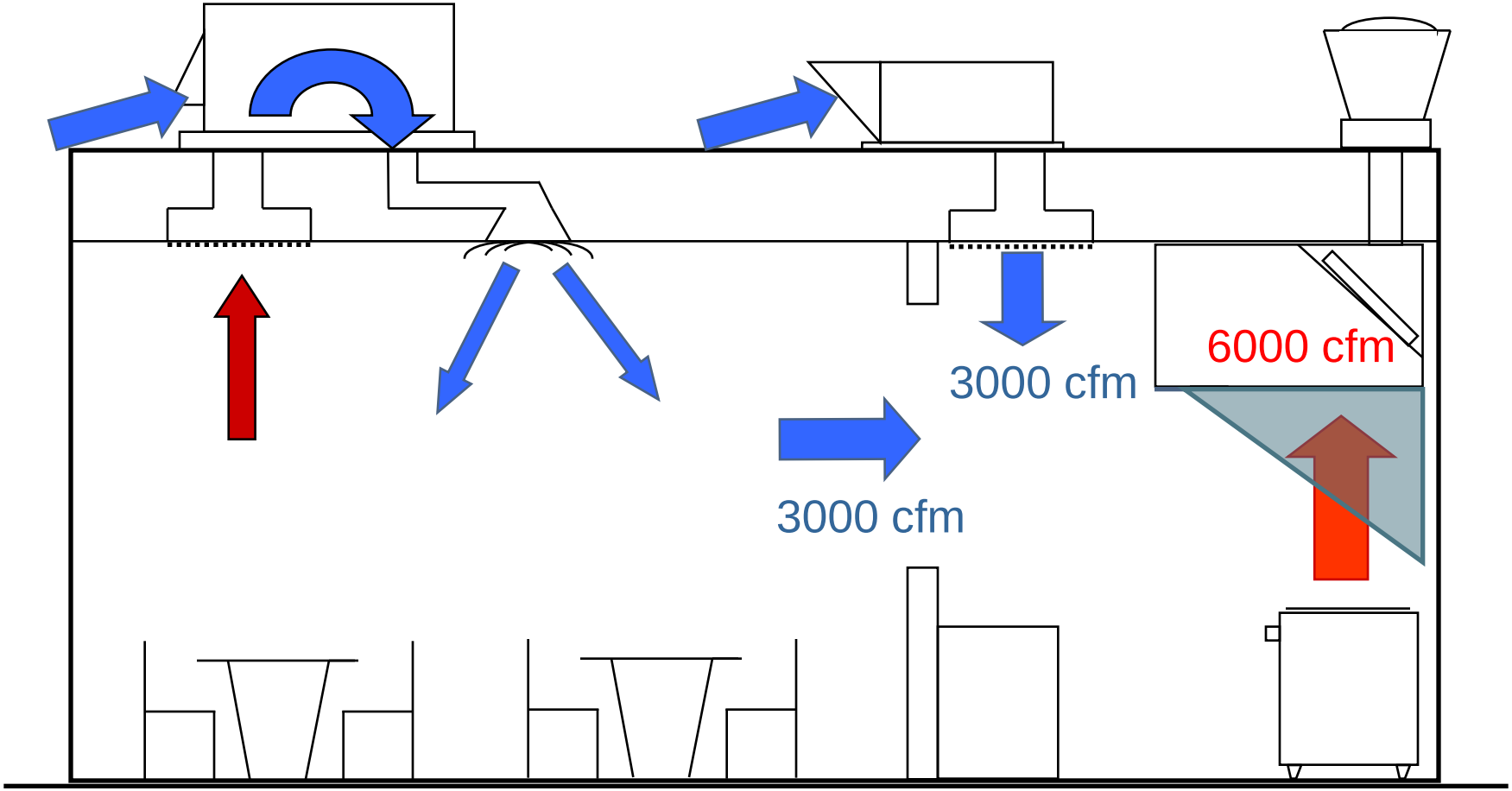


On an air balance schedule the difference is very subtle…



Non-integrated design

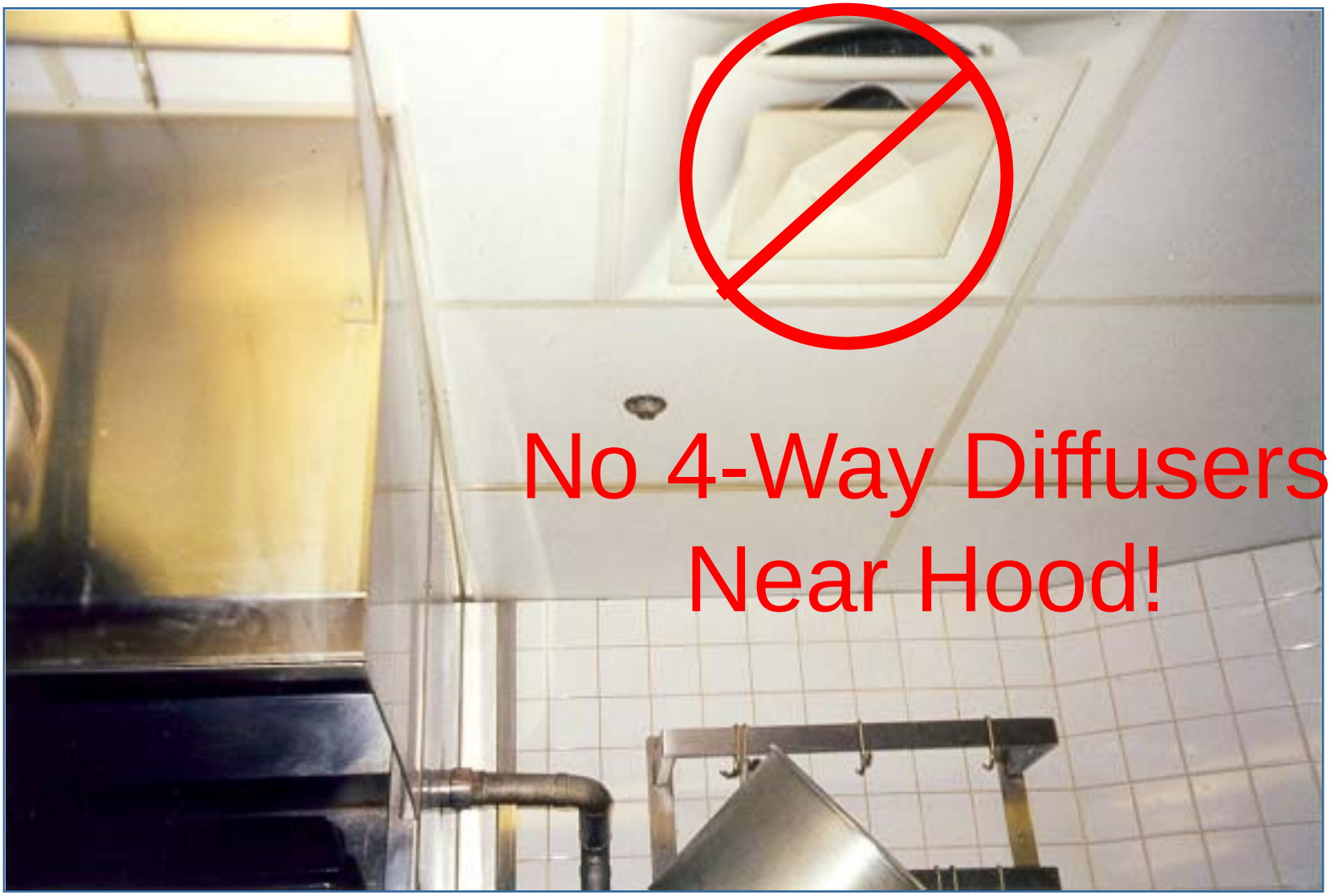
…but the thermal comfort impact may be huge!



Integrated design

Wall Canopy with Displacement MUA (C&C = 4100 cfm, 2 charbroilers cooking)

Proximity Hood with Displacement MUA (C&C = 1250 cfm, 2 charbroilers cooking)


No 4-Way Diffusers
Near Hood!

Displacement Ventilation

KitchenSOX™

DUCTSOX®

Perforated Supply Plenum (PSP)

ASHRAE Standard 90.1 - 2010

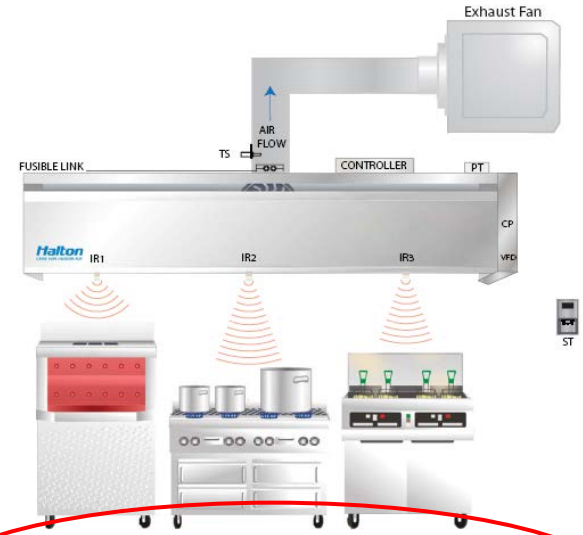
If a kitchen/dining facility has a total kitchen hood exhaust airflow rate greater than 5,000 cfm then it shall have one of the following:

a) At least 50% of all replacement air is transfer air that would otherwise be exhausted.

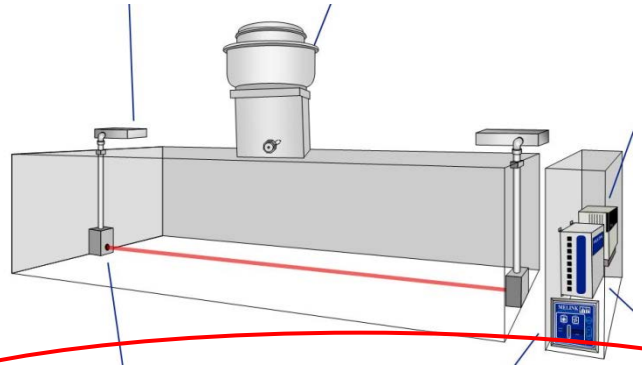
b) Demand ventilation system(s) on at least 75% of the exhaust air. Such systems shall be capable of at least 50% reduction in exhaust and replacement air system airflow rates, including controls necessary to modulate airflow in response to appliance operation and to maintain full capture and containment of smoke, effluent and combustion products during cooking and idle.

c) Listed energy recovery devices with a sensible heat recovery effectiveness of not less than 40% on at least 50% of the total exhaust airflow.

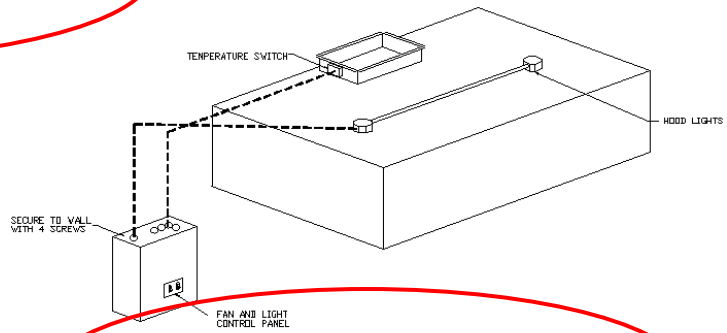
Demand Ventilation Control Technologies



Duct Temperature Sensor & Infrared Sensors



Duct Temperature Sensor & Smoke Detection

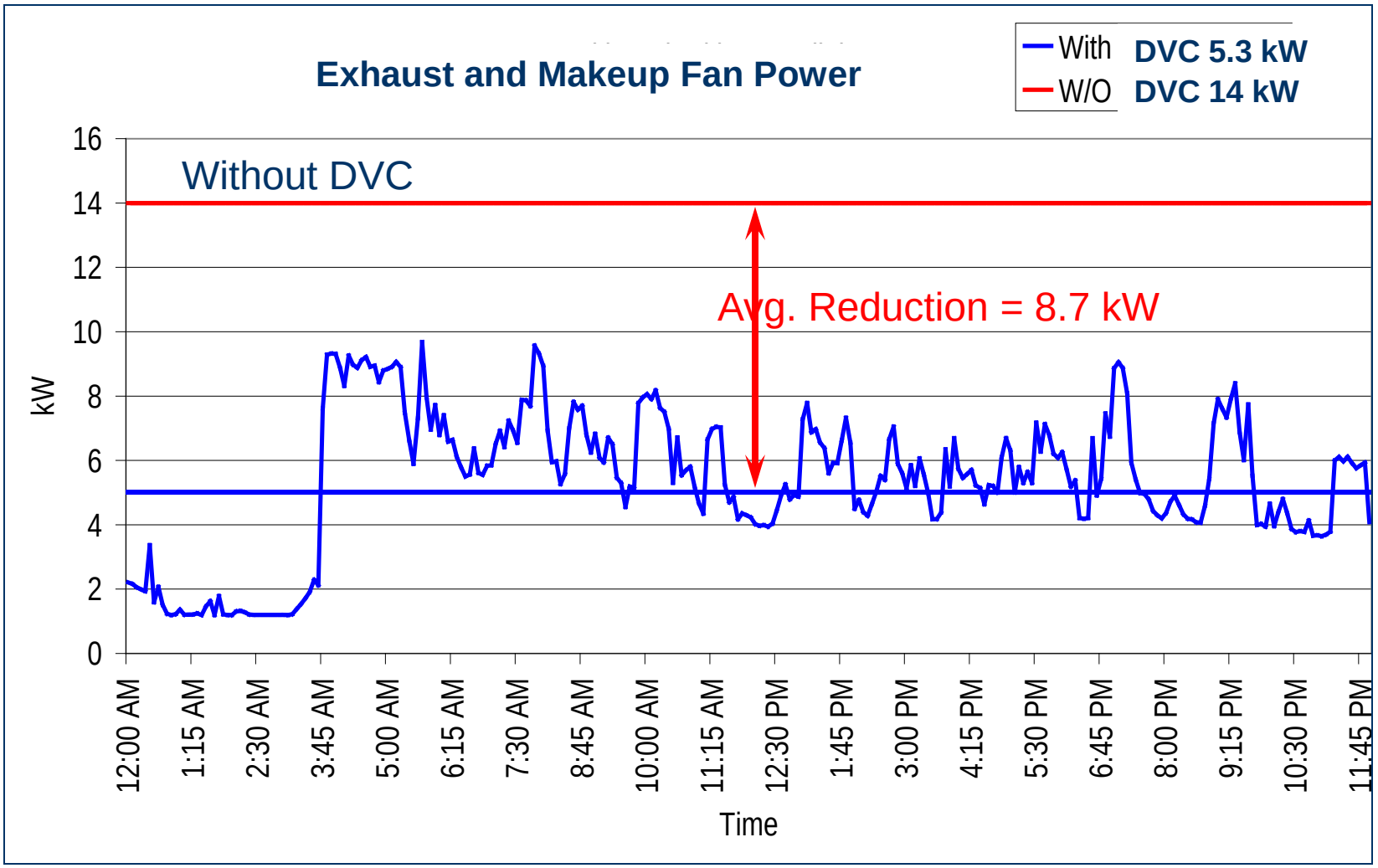


Duct Temperature Sensor

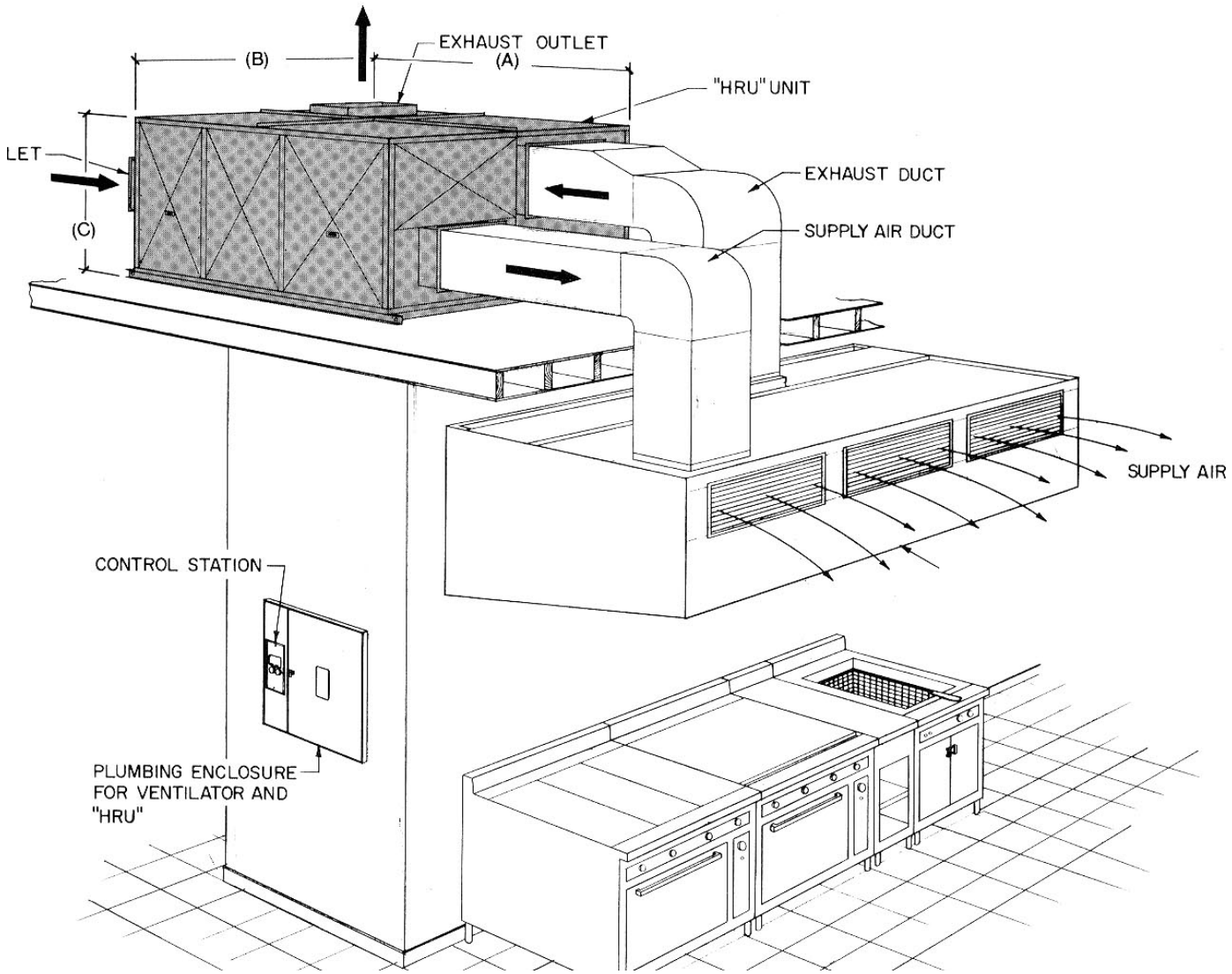
Large Hotel Kitchen

Front Line

Back Line

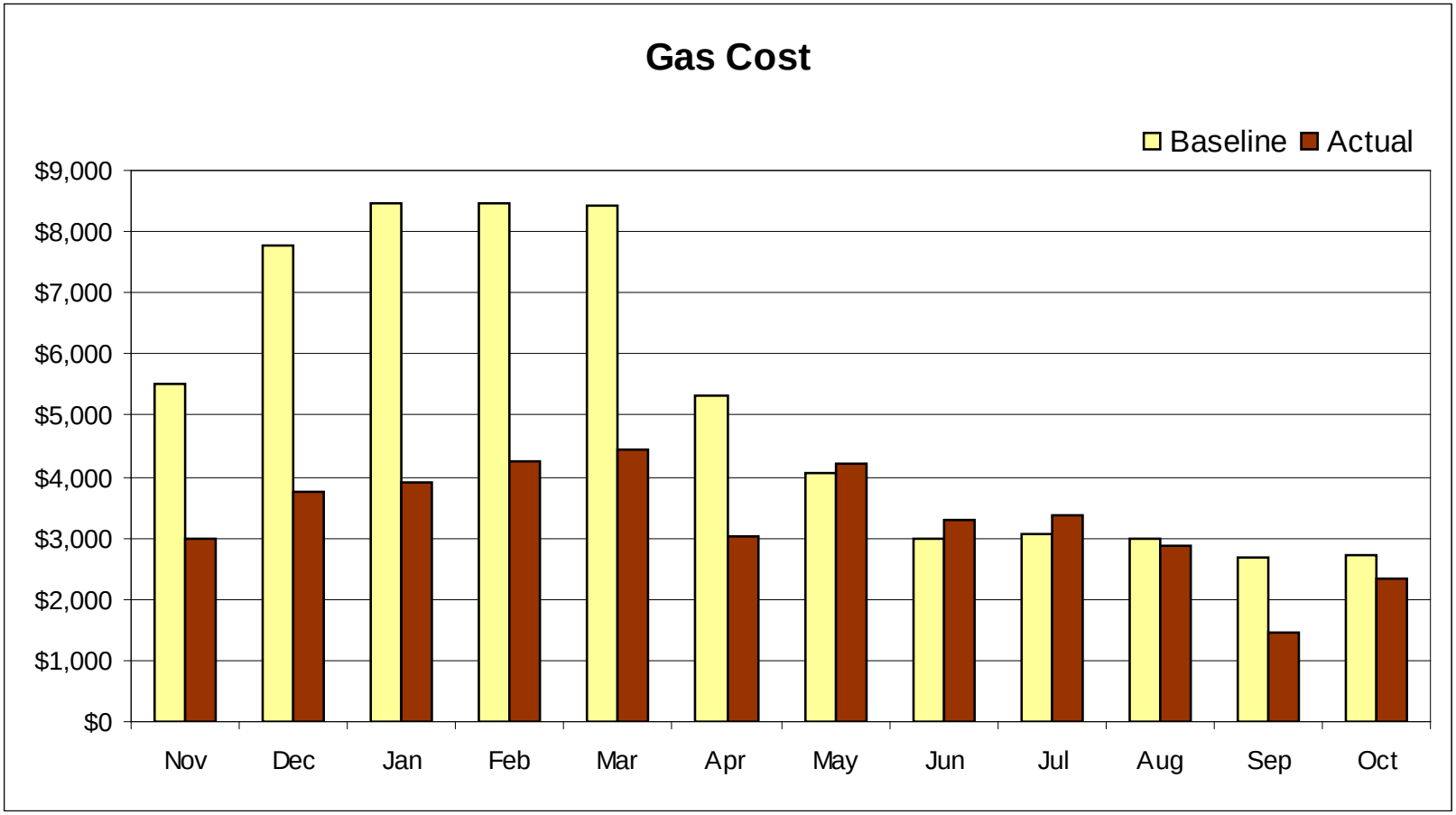

Exhaust and Makeup Fan Power
With DVC 5.3 kW
W/O DVC 14 kW
Without DVC
Avg. Reduction = 8.7 kW
kW
16
14
12
10
8
6
4
2
0
12:00 AM
1:15 AM
2:30 AM
3:45 AM
5:00 AM
6:15 AM
7:30 AM
8:45 AM
10:00 AM
11:15 AM
12:30 PM
1:45 PM
3:00 PM
4:15 PM
5:30 PM
6:45 PM
8:00 PM
9:15 PM
10:30 PM
11:45 PM
Time

Air-to-Air Heat Recovery Unit



West Point

Air-to-Air HX – Toronto Restaurant



36% reduction = $22,600 per year!
(at $1.30/therm)

FSTC

FOOD SERVICE TECHNOLOGY CENTER

PROMOTING ENERGY EFFICIENCY IN FOODSERVICE

Thanks!

be energy wise

save energy, save money,
save the environment.

fishnick.com