# Demonstration of High-Efficiency Hot Water Systems in Commercial Foodservice

*Frontier Energy, Inc. (formerly Fisher-Nickel, Inc.) is a dedicated team of engineers, technicians, educators, and water and energy specialists who use their expertise to encourage sustainability within the commercial foodservice industry—upstream by assisting manufacturers with product and test method development and creation of product incentive programs, and downstream by helping designers and commercial kitchen operators with their system design, purchasing decisions, operations and maintenance.*

## Completion of Demonstration Project

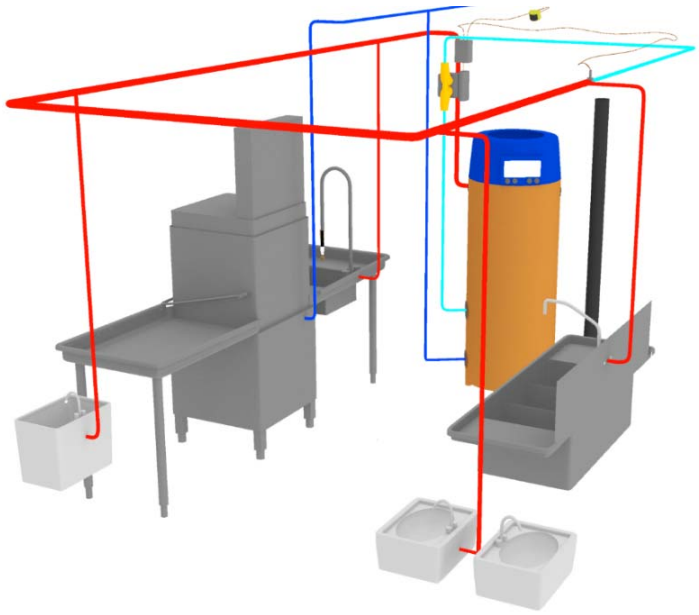
Frontier Energy, operator of the Food Service Technology Center (FSTC) was awarded in 2014, a California Energy Commission (CEC) Building Natural Gas Technology grant for to conduct the *Demonstration of High-Efficiency Hot Water Systems in Commercial Foodservice* project, which they completed in 2018.

## Hot Water System (HWS) Testing

The primary goal of this research-based demonstration project was to document the efficiency of the hot water generation to the fixtures by measuring delivered energy and water use throughout the system. Baseline (original) and optimized (replacement) HWS testing at two California field sites was combined with testing and validation of optimization techniques in the laboratory to develop a design tool and cost calculator for designers and the rest of the industry.

## Field Demonstrations

Frontier Energy monitored the original and replacement HWSs at The Counter restaurant in San Mateo, co-funded by Pacific Gas & Electric Company (PG&E), and at Franklin Elementary School in Santa Barbara co-funded by SoCalGas. At The Counter, researchers replaced the original tankless water heaters, conventional distribution system and high-temp door-type dishmachine with an optimized system to demonstrate advanced design concepts and technologies for major retrofit and new-design applications. The site was outfitted with a high-efficiency dishmachine with an integrated heat-recovery



system, and a condensing storage water heater. The most innovative components included a redesigned compact hot water distribution loop to supply just the back-of-house fixtures and equipped with a D'MAND Kontrols® recirculation system, and five decentralized point-of-use electric heaters installed at distant locations at the bar and restroom sinks. This replacement system greatly improved performance of the centralized water heater and hot water delivery performance at the bar and restroom sinks. Changes made at this site saved 32% water and 77% natural gas with only a 5% increase in electricity use, which equate to **a total utility cost savings of $6,200 per year.** At Franklin Elementary, researchers demonstrated easily retrofittable technologies such as condensing water heaters, ENERGY STAR® dishmachines, ECM potable water pump, and a smart recirculation controller. Changes made at this site saved 42% water, 44% electricity and 54% gas, **a total utility cost savings of $3,330/year.**

## Validating Savings in the Laboratory

Frontier Energy teamed up with researchers at the PG&E Applied Technologies Services Hot Water System Laboratory in San Ramon to quantify the savings from various HWS components applied in a controlled test environment. The lab featured two distribution systems modeled after The Counter—one representing the

Frontier Energy – fishnick.com – 925.866.2844
12949 Alcosta Blvd., Suite 101, San Ramon, CA 94583

baseline system and the other representing the optimized system. While simulating the draw profiles measured in the field study, the lab measured energy and water use and delivery performance and calculated water heater operating efficiency and out-of-wall system efficiency of over 70 different configurations. The test configurations included four types of water heaters and 5 types of recirculation control strategies. The testing also varied recirculation pump flow rate and recirculation return location on the condensing storage heater. Major new findings were that (1) among those tested, the simulated demand system was the best recirculation control strategy for delivering high system efficiencies with minor impact of delivery performance, (2) lowering recirculation flow rate improved system efficiency especially on storage heaters, and (3) using the upper return port on condensing storage water heaters improved the water heater efficiency.

## Impact of Dishmachines

Dishmachines are typically the largest users of hot water, and the field study confirmed that the total energy and water use was largely dishmachine driven. New dishmachines have an option for exhaust-air heat recovery, which is designed to capture the heat from the steam produced during the washing process to preheat the inlet water. Some dishmachines with this feature utilize only a cold-water supply connection, which allows the HWS to be downsized and for the water heater temperature to be turned down by up to 20°F. This scenario was demonstrated at The Counter.

## Technology Transfer

This project has resulted in multiple conference presentations and educational seminars in California and around the country, namely at ASHRAE, ACEEE Hot Water Forum, CEE, IAPMO, CEHA and California foodservice technology centers. The field study results have been showcased in two case studies. Additionally, lessons learned were included in an update to the *Hot Water System Design Guide* and companion *Design Examples* document. The laboratory and field results were incorporated into a design tool and cost calculator to help plumbing engineers and kitchen designers compare the performance, efficiency, installed cost, and operating cost of conventional systems to modern systems with and without the efficiency upgrades. An intuitive user interface allows the selection of different water heaters, distribution systems, recirculation controls, and dishmachines. The calculator then outputs the system installation cost, applicable rebates, operating cost and payback period. For more detailed project information, presentations, case studies, and the full report, please visit: https://fishnick.com/cecwater/

## Benefits for California

The technologies and design strategies and their associated savings demonstrated in this project are applicable to all commercial foodservice facilities. It is estimated that there are 100,000 commercial foodservice facilities operating in California. As a cursory calculation, using the average annual savings from the two field projects of 115 HCF, 2,190 therms, and -525 kWh applied to all 100,000 facilities, the sector would yield an annual savings of 11.5 Million HCF of water, 219 million therms of natural gas, an excess use of 52,500 MWh of electricity (potentially mitigated with on-site generation) and operating cost savings of 360 million dollars.

| | Restaurant Savings | School Savings | Average Savings* |
|---|---|---|---|
| Water (HCF/y) | 125 | 105 | 115 |
| Gas (therms/y) | 2,050 | 2,330 | 2,190 |
| Electricity (kWh/y) | -2,020 | 970 | -525 |
| Annual Cost | $6,200 | $3,330 | $3,600 |

*Average cost savings based on 2018 average California utility rates of $11.25/HCF, $0.19/kWh, and $1.10/therm.

In addition, the water heater and distribution system findings are applicable to the wider commercial and industrial segments and some residential segments. Overall, the CEC and the energy utilities can best capitalize on the study results by using them as a basis to better shape building efficiency policies, expand incentives, and move the industry away from standard HWS designs and conventional equipment.

This fact sheet summarizes the *Demonstration of High-Efficiency Hot Water Systems in Commercial Foodservice project* conducted by Frontier Energy on behalf of the CEC Natural Gas Research and Development Program. Contract Number PIR 14-006