

# Digi-RTU 4.0 Released:

## Restaurants and Gas Stations Applications

### Project Information

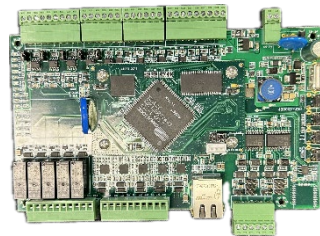
Digi-RTU4.0 technology demonstration is implemented to total fourteen (14) units at six (6) gas stations and fast-food restaurants located in Omaha, NE between November 2023 and February 2024. Table 1 summarizes the site and unit information. The system performance is monitored with Digi-SBM remote monitoring system after the Digi-RTU4.0 is installed. This report presents the overview of Digi-RTU4.0 technology and the demonstration results.

**Table 1: List of RTU Information**

Site Name	Unit Tag	Size (ton)	Serving area	Model
Customer 1-R1	RTU-1	10	Kitchen	Digi-RTU 1C
	RTU-2	7.5	Dining	Digi-RTU 1C
Customer 1-R2	RTU-1	5	Dining	Digi-RTU 1C
	RTU-2	5	Dining	Digi-RTU 1C
	RTU-3	10	Kitchen	Digi-RTU 2C
Customer 2-G1	RTU-1	10	Kitchen	Digi-RTU 2C
	RTU-2	10	Store area	Digi-RTU 2C
Customer 2-G2	RTU-1	7.5	Kitchen	Digi-RTU 2C
	RTU-2	5	Store area	Digi-RTU 1C
	RTU-3	7.5	Store area	Digi-RTU 2C
Customer 3-R1	RTU-1	10	Kitchen	Digi-RTU 2C
	RTU-2	15	Dining	Digi-RTU 2C
Customer 4-G1	RTU-10	10	Kitchen	Digi-RTU 1C
	RTU-18	18	Store area	Digi-RTU 2C

### Digi-RTU4.0 Technology Descriptions

Digi-RTU4.0 technology is the ultimate solution for package rooftop units. The main brain of the Digi-RTU4.0 technology is the Digi-RTU4.0 smart controller.



**Figure 1: Photo of Digi-RTU4.0 smart controller**

The technology has the following functionalities:

1. Operation & Maintenance (O&M)
  - a. Occupancy schedule  
Built-in programmable occupancy schedule and holiday schedule
  - b. Automatic VFD setup

- c. Maintenance service
  - Automatic functional test
- 2. Safety/Lockout
  - a. Shut down unit under fire alarm
  - b. Heater safety protection and lockout
  - c. Indoor fan safety protection and lockout
  - d. Compressor safety protection and lockout
- 3. Control functions
  - a. Comfort control
    - Control space temperature, space relative humidity, space pressure
  - b. Mechanical control
    - Ventilation, economizer, heating and cooling
  - c. Special control
    - Demand controlled ventilation, dehumidification control, demand limiting, demand response, system cycling during unoccupied period, optimal warm-up or cool-down during scheduled occupancy.
- 4. Faults detection and diagnosis
  - a. Sensor FDD
  - b. VFD FDD
  - c. Economizer damper fault
  - d. Fan fault
  - e. Compressor fault
  - f. Low charge
  - g. Condenser fan fault
- 5. Performance monitoring
  - a. Power
    - Monitoring fan power, compressor power, condenser fan power
  - b. Energy

Digi-RTU4.0 technology has the following salient features:

1. Convert fixed speed or multi-speed system to full variable speed system for best system efficiency
2. Provide faults detection and diagnosis
3. Innovative safety protection based on motor power
4. Integration with BAS via open communication protocol
5. Built-in blue tooth for easy onsite service

Digi-RTU4.0 technology has the following benefits:

1. Better space temperature and RH control and improve the building comfort
2. Significant fan and compressor energy savings (30% to 60%)
3. Significant peak demand savings (20% to 40%)
4. Improve the equipment reliability

5. Reduce the O&M cost

### Digi-RTU4.0 Technology Demonstration Results

Digi-RTU4.0 performance is measured by running the unit in Digi mode and base mode for 24 hours separately under the similar weather condition (the daily outdoor air temperature varies from 70°F to 90°F). The following table summarizes the daily energy and demand savings as well as compressor cycle reduction for each site. The energy savings under summer hot weather ranges from 27.1% to 49.3%, the demand savings range from 4.3% to 34.4%, and the compressor cycle reduction ranges from 10.5% to 57.3%. Detailed performance data can be found in Appendix A. The measured results represent the Digi-RTU4.0 savings during summer peak weather conditions.

**Table 2: Summary of Summer Savings Results**

Customer	Facility	Tonnage	Savings/Reduction (%)		
			Energy	Demand	Cycle
Customer 1-R1	Restaurant	17.5	27.5	4.3	45.8
Customer 1-R2	Restaurant	20	45.9	19.6	20.7
Customer 2-G1	Gas Station	20	27.1	10.2	
Customer 2-G2	Gas Station	20	49.3	23.1	17.1
Customer 3-R1	Restaurant	25	35.8	28	10.5
Customer 4-G1	Gas Station	26	35.1	34.4	57.3

During the technology demonstration, various faults and safety lockouts on the mechanical equipment were identified. The following table summarizes the faults and safety lockouts registered and verified during the demonstration period.

**Table 3: List of registered faults and safety lockouts**

Site	Unit	Fault/safety lockout	Repair
Customer 1-R2	RTU-2	VFD fault	Tightened the connection
	RTU-3	SAT sensor fault	Added heat shield to the sensor cable
Customer 2-G2	RTU-1	Heater lockout	Replaced the safety switches
	RTU-2	Low charge	Added charge
Customer 3	Kitchen unit	VFD fault	Replaced the filter/dryer

## Appendix A

### Customer 1-R1

Table 4: Demand and Energy reduction for Customer 1-R1

Unit #	Capacity (ton)	Peak Power (kW)			Daily Energy (kWh)			Daily Compressor Cycles		
		Base	Digi	Reduction	Base	Digi	Reduction	Base	Digi	Reduction
RTU-1	10	9.60	9.48	1.3%	161	122	24.3%	34	33	3%
RTU-2	7.5	1.5	1.2	19%	61	39	36.3%	107	58	66%

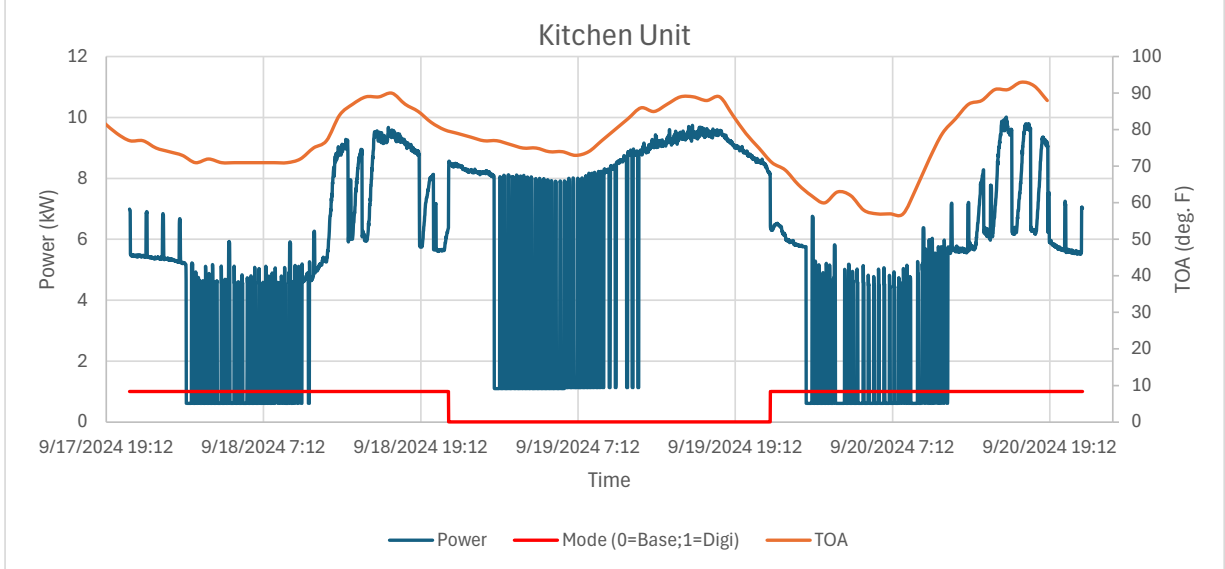


Figure 2: Power Consumption in Baseline and Digi Operation Modes for RTU-1 (Kitchen Unit)

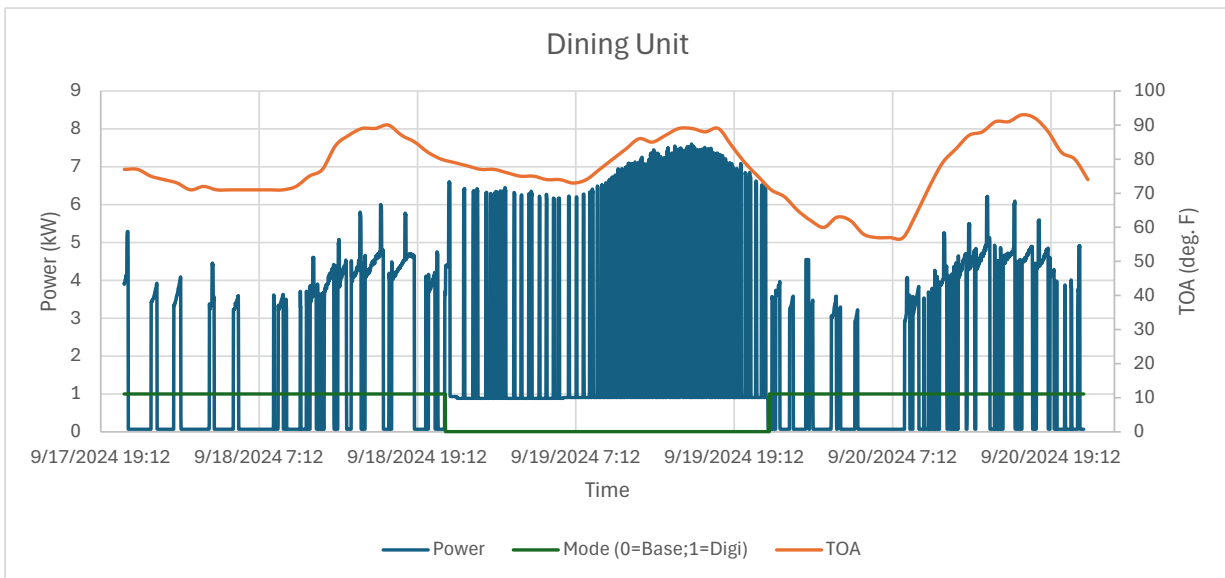


Figure 3: Power Consumption in Baseline and Digi Operation Modes for RTU-2 (Dining Unit)

## Customer 1-R2

Table 5: Demand and Energy reduction for Customer 1-R2

Unit #	Capacity (ton)	Peak Power (kW)			Daily Energy (kWh)			Daily Compressor Cycles		
		Base	Digi	Reduction	Base	Digi	Reduction	Base	Digi	Reduction
RTU-1	5	4.42	4.24	4.2%	66	33	49.2%	50	38	24.0%
RTU-2	5	7.45	5.60	24.8%	103	88	15.1%	57	48	15.8%
RTU-3	10	9.27	7.16	22.7%	151	52	65.4%	33	25	24.2%

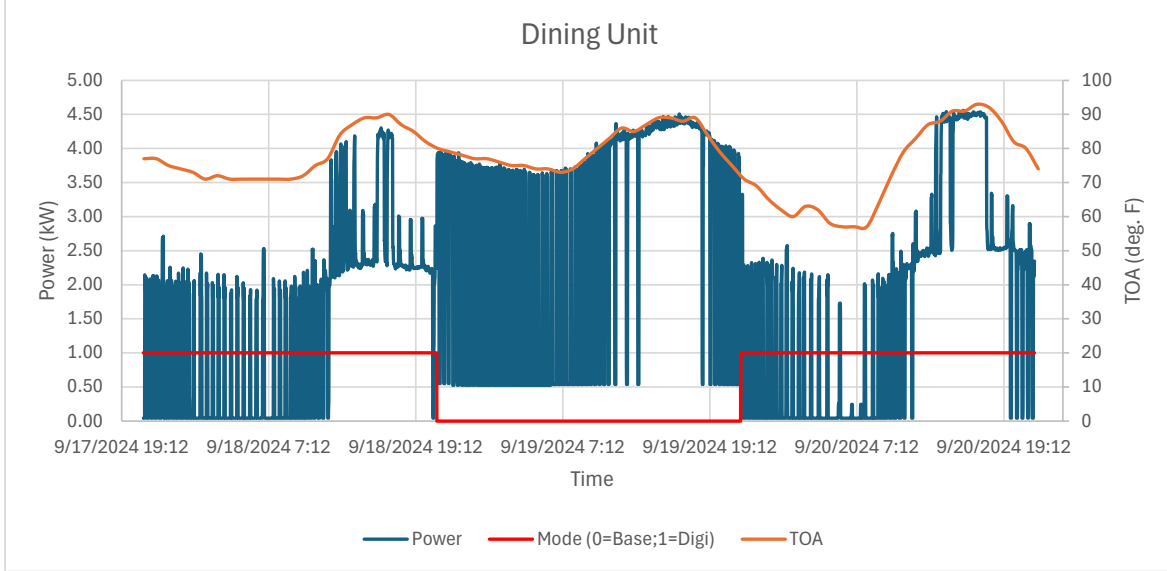


Figure 4: Power Consumption in Baseline and Digi Operation Modes for RTU-1 (Dining Unit)

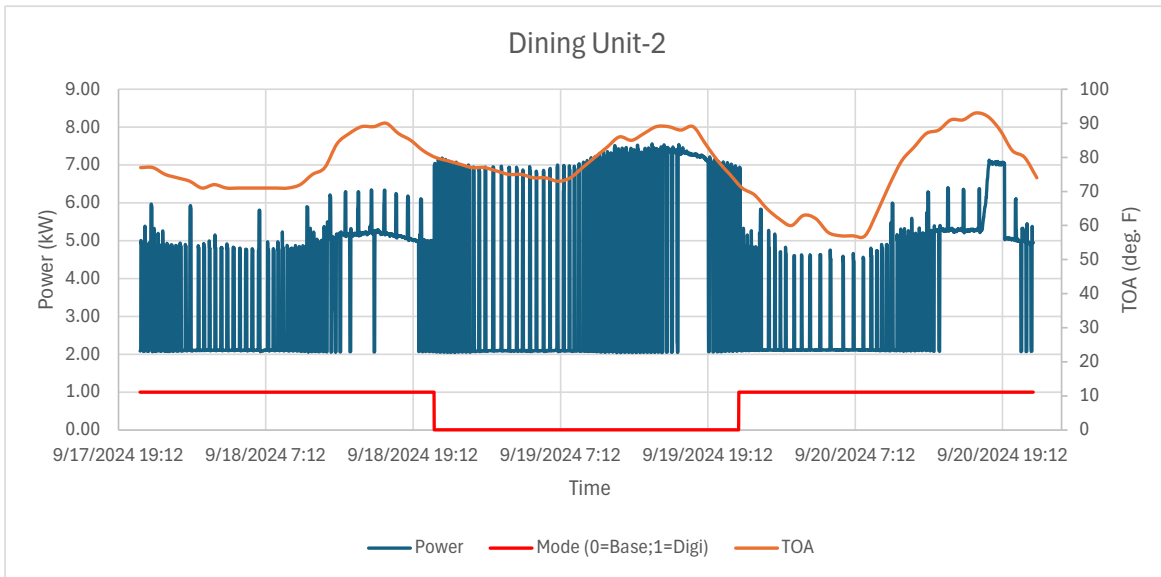


Figure 5: Power Consumption in Baseline and Digi Operation Modes for RTU-2 (Dining Unit)

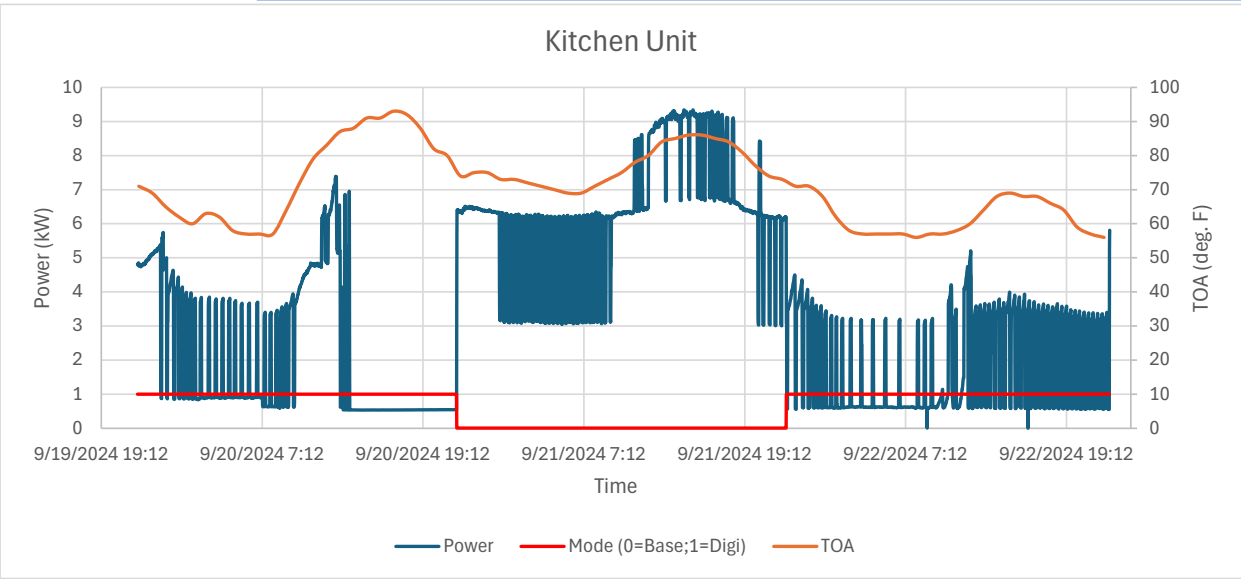


Figure 6: Power Consumption in Baseline and Digi Operation Modes for RTU-3 (Kitchen Unit)

## Customer 2-G1

Table 6: Demand and Energy reduction for Customer 2-G1

Unit #	Capacity (ton)	Peak Power (kW)			Daily Energy (kWh)			Daily Compressor Cycles		
		Base	Digi	Reduction	Base	Digi	Reduction	Base	Digi	Reduction
RTU-1	10	9.46	7.94	16.0%	45	32	27.4%	-	-	-
RTU-2	10	9.94	9.48	4.6%	173	127	26.6%	-	-	-

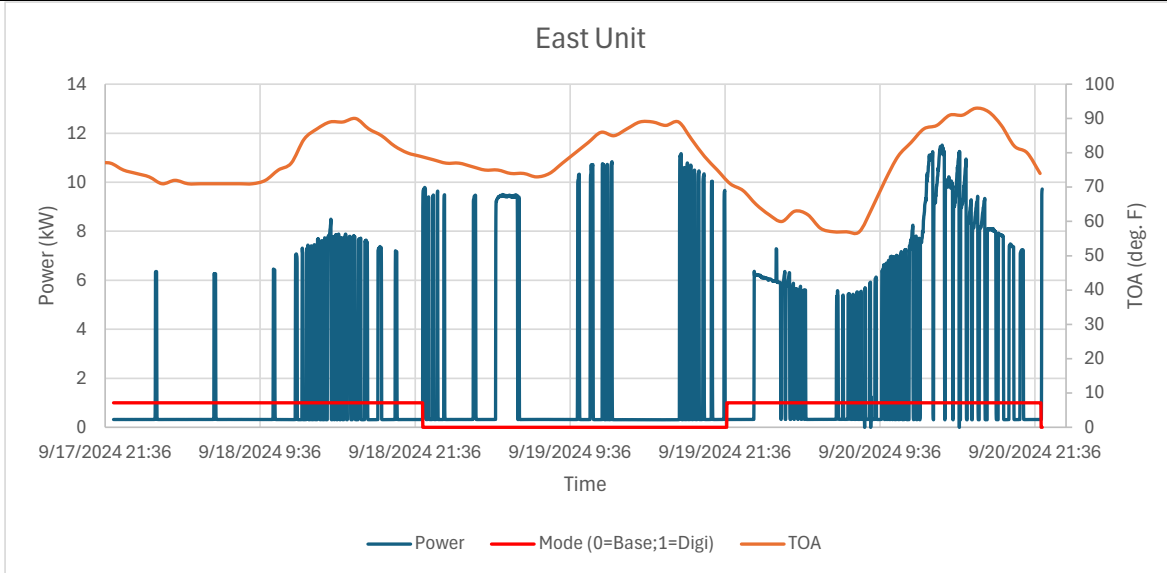


Figure 7: Power Consumption in Baseline and Digi Operation Modes for RTU-1 (East Unit)

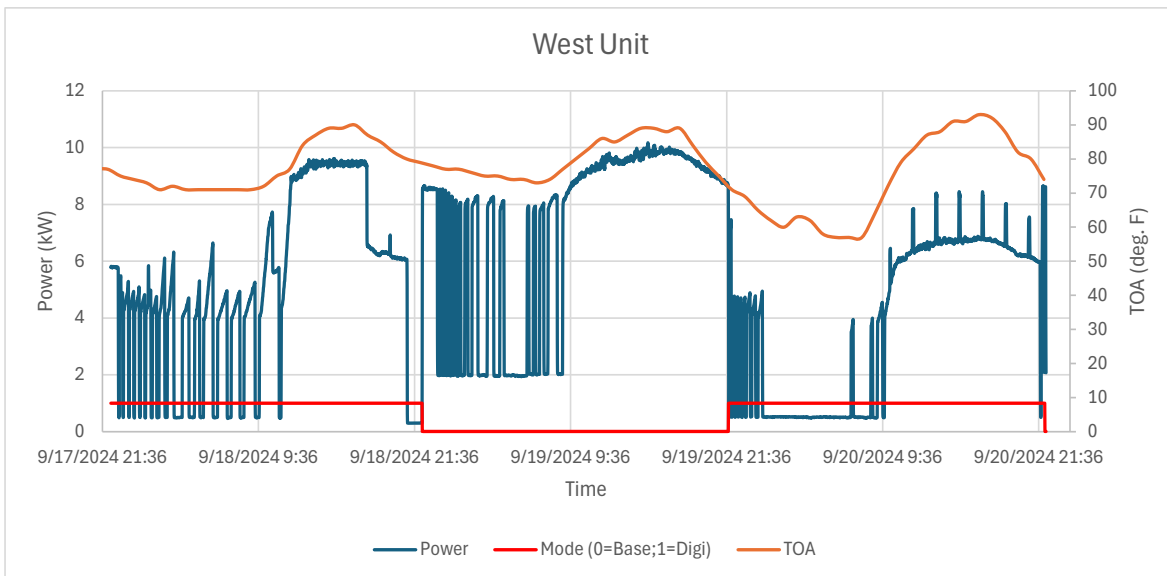


Figure 8: Power Consumption in Baseline and Digi Operation Modes for RTU-2 (West Unit)

Customer 2-G2

Table 7: Demand and Energy reduction for Customer 2-G2

Unit #	Capacity (ton)	Peak Power (kW)			Daily Energy (kWh)			Daily Compressor Cycles		
		Base	Digi	Reduction	Base	Digi	Reduction	Base	Digi	Reduction
RTU-1	7.5	5.38	2.56	52.3%	80	32	59.5%	122	76	37.7%
RTU-2	5	4.46	4.39	1.6%	61	42	31.3%	63	54	14.3%
RTU-3	7.5	4.03	3.71	7.9%	66	31	53.7%	49	64	-30.6%

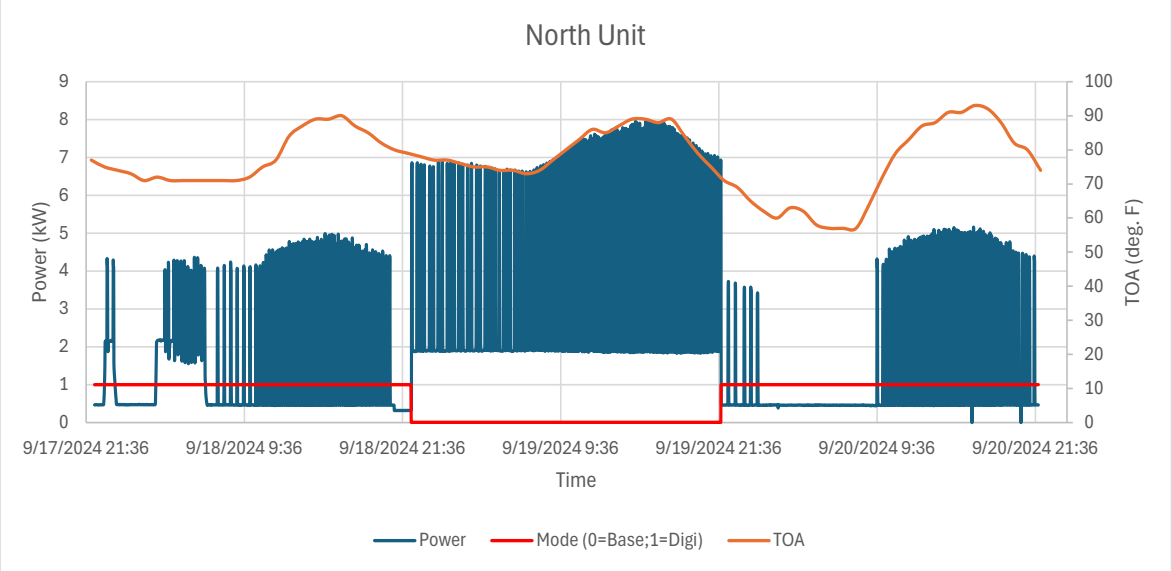


Figure 9: Power Consumption in Baseline and Digi Operation Modes for RTU-1 (North Unit)

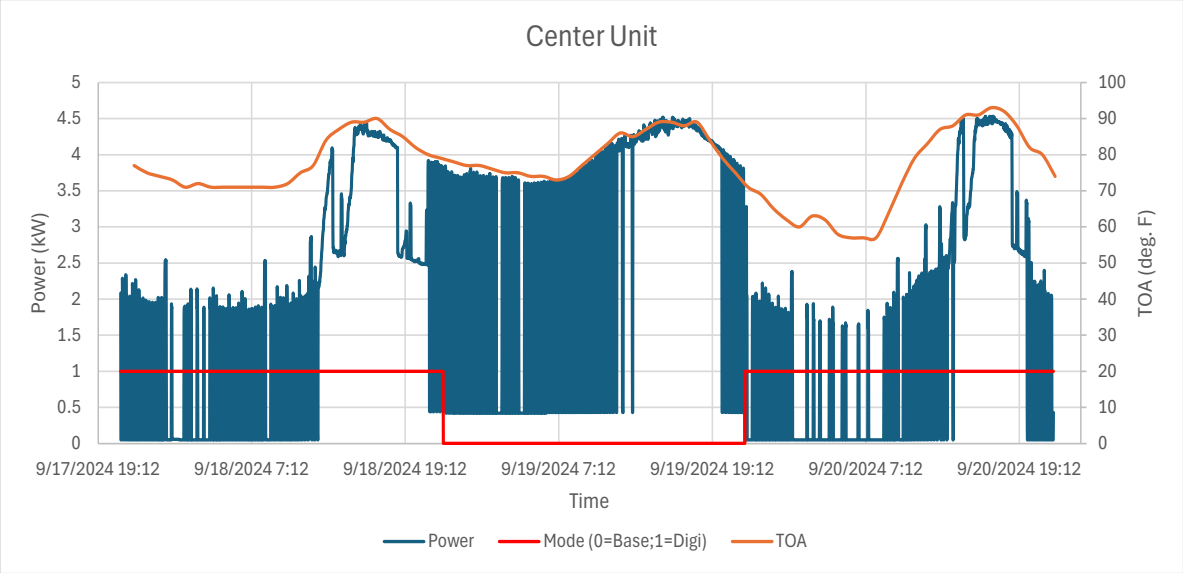


Figure 10: Power Consumption in Baseline and Digi Operation Modes for RTU-2 (Center Unit)



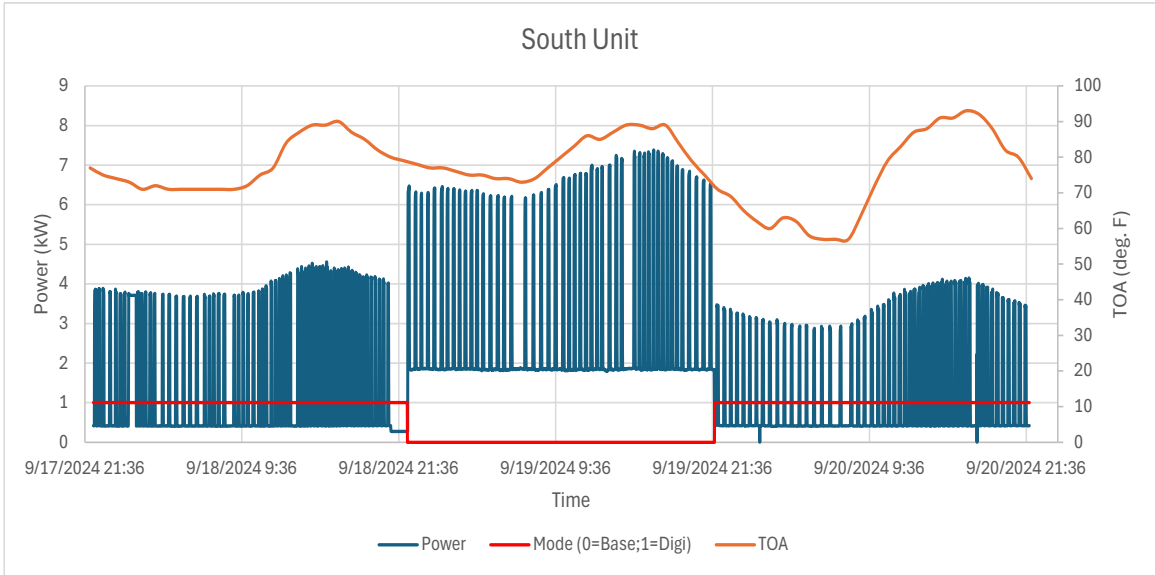


Figure 11: Power Consumption in Baseline and Digi Operation Modes for RTU-3 (South Unit)

Customer 3-R1

Table 8: Demand and Energy reduction for Customer 3-R1

Unit #	Capacity (ton)	Peak Power (kW)			Daily Energy (kWh)			Daily Compressor Cycles		
		Base	Digi	Reduction	Base	Digi	Reduction	Base	Digi	Reduction
RTU-1	10	8.79	7.78	11.5%	148	95	36.0%	-	-	-
RTU-2	15	15.44	9.66	37.4%	154	99	35.8%	38	34	10.5%

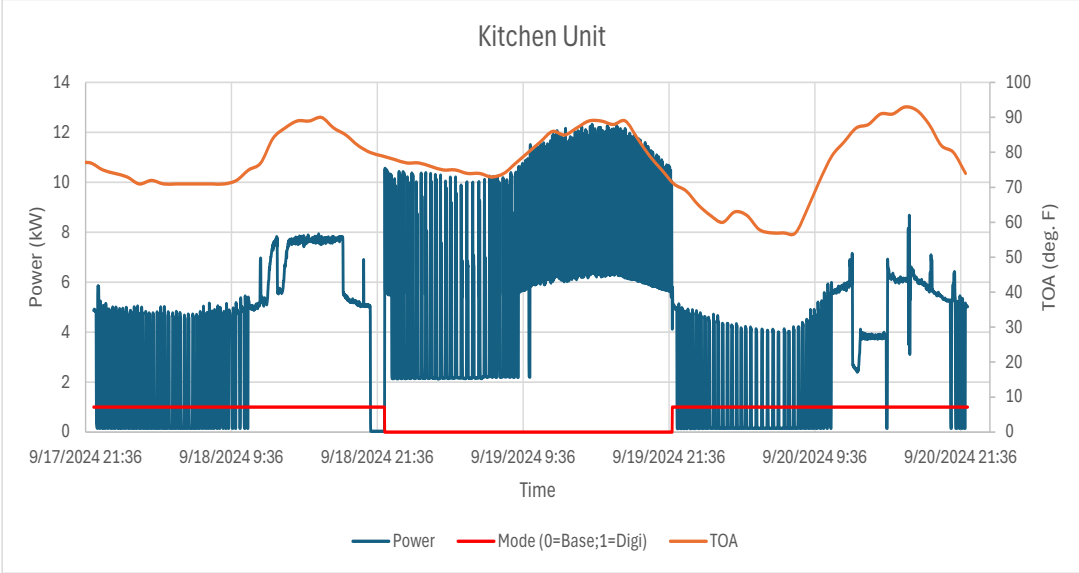


Figure 12: Power Consumption in Baseline and Digi Operation Modes for RTU-1 (Kitchen Unit)

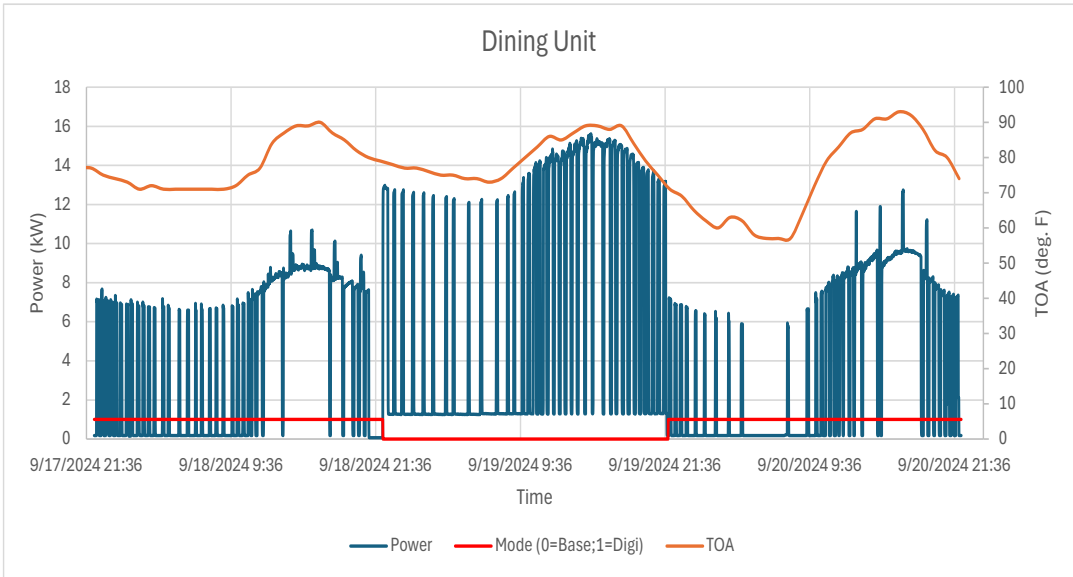


Figure 13: Power Consumption in Baseline and Digi Operation Modes for RTU-2 (Dining Unit)

Customer 4-G1

Table 9: Demand and Energy reduction for Customer 4-G1

Unit #	Capacity (ton)	Peak Power (kW)			Daily Energy (kWh)			Daily Compressor Cycles		
		Base	Digi	Reduction	Base	Digi	Reduction	Base	Digi	Reduction
RTU-10	10	9.74	8.24	15.5%	193	138	28.4%	48	5	89.5%
RTU-18	18	18.22	10.09	44.6%	146	82	44.1%	34	30	11.7%

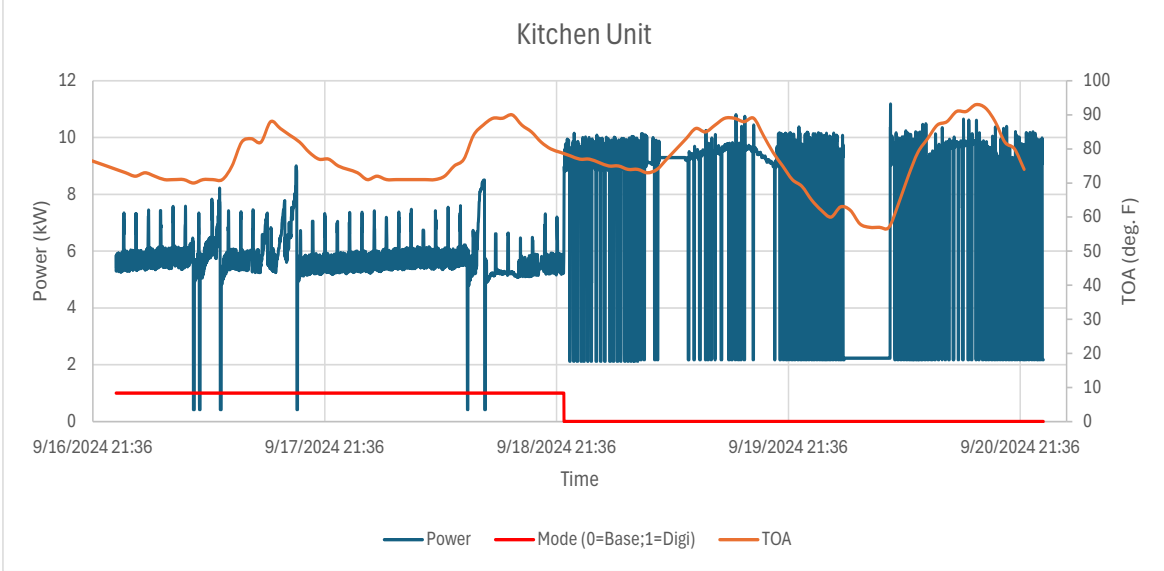


Figure 14: Power Consumption in Baseline and Digi Operation Modes for RTU-10 (Kitchen Unit)

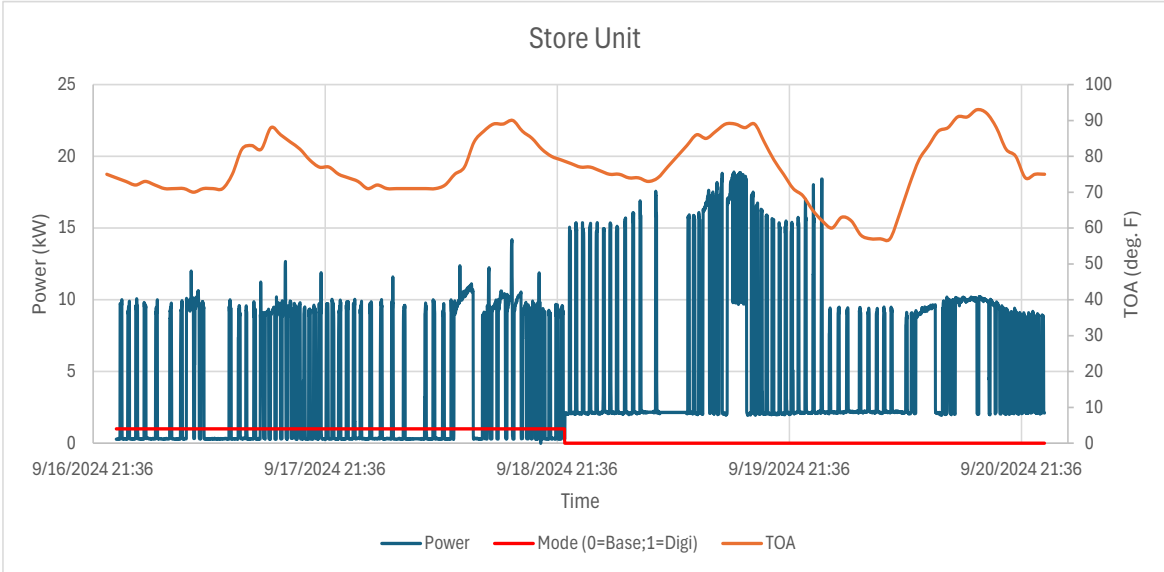


Figure 15: Power Consumption in Baseline and Digi Operation Modes for RTU-18 (Store Unit)