

Heat Pump Research Project

Sponsored by the

Heat Pump Working Group

February 7, 2005



Study Goals

- Establish determinants of heat pump efficiency
- Determine impact of commissioning refrigerant charge and air flow on heat pump performance
- Establish the current practice for heat pump installation (controls, staging, sizing) in the region
- Determine the impact of heat pumps installed in utility programs compared to conventional installations
- Develop heat pump market information from installers, suppliers and distributors

Study Components

- Lab tests (Purdue)
- 5 target markets with control groups; reduced to 4
 - 160 home field review
 - 1700 home billing analysis
 - 600 home separate study at EWEB to evaluate retro-commissioning for charge and airflow
- 5 homes with detailed metering (ODOE)
- Interview 40 “market actors” in all major regional markets

Laboratory Testing

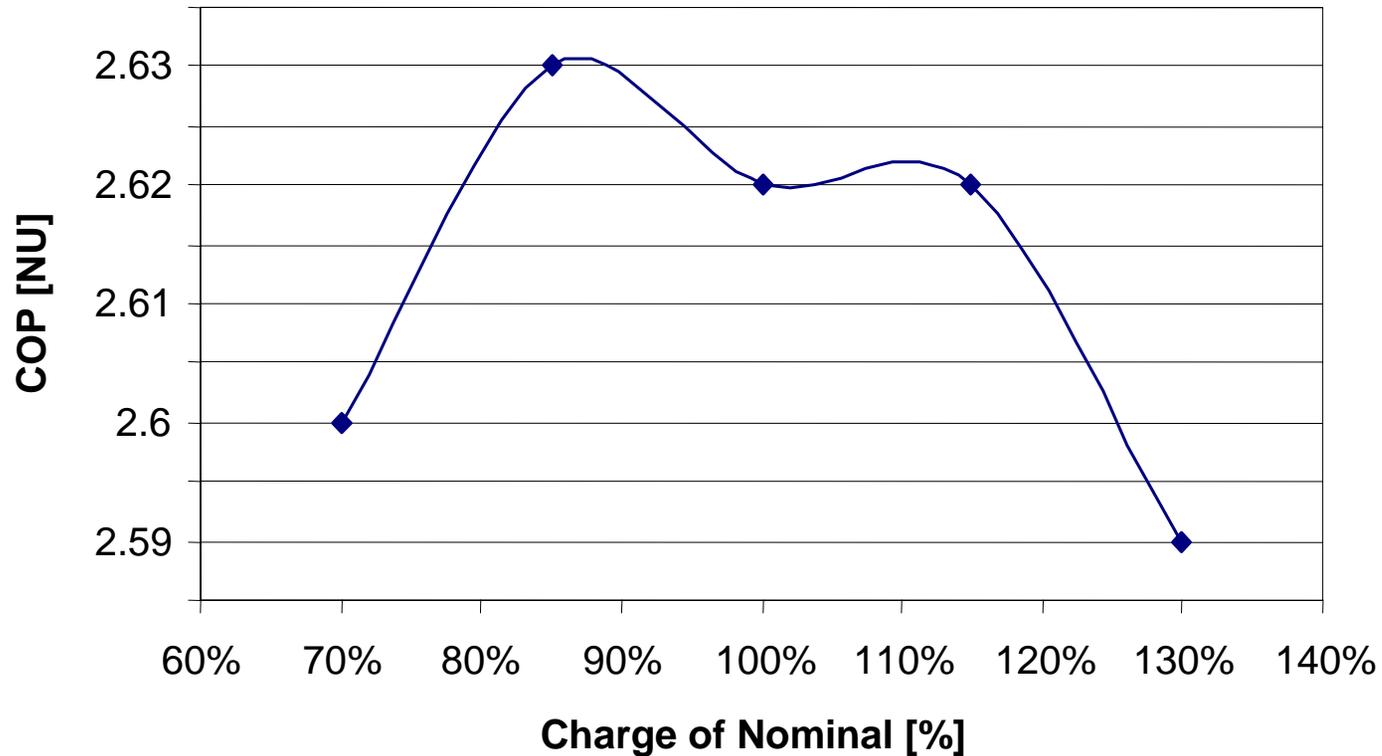
- Performance impacts of charge and airflow
 - Fixed metering
 - TXV
 - Cycling test (C_d determination)
- Preliminary results based on 70% of the first group
- Added tests

Preliminary Results

- Total variation of less than 2% in COP over the range of tests
- Indications of fall off but very small effect on COP
- Air flow can result in up to a 10% reduction in capacity and up to 4% reduction in COP
- Main effect at very low flows (under 300 CFM/ton)

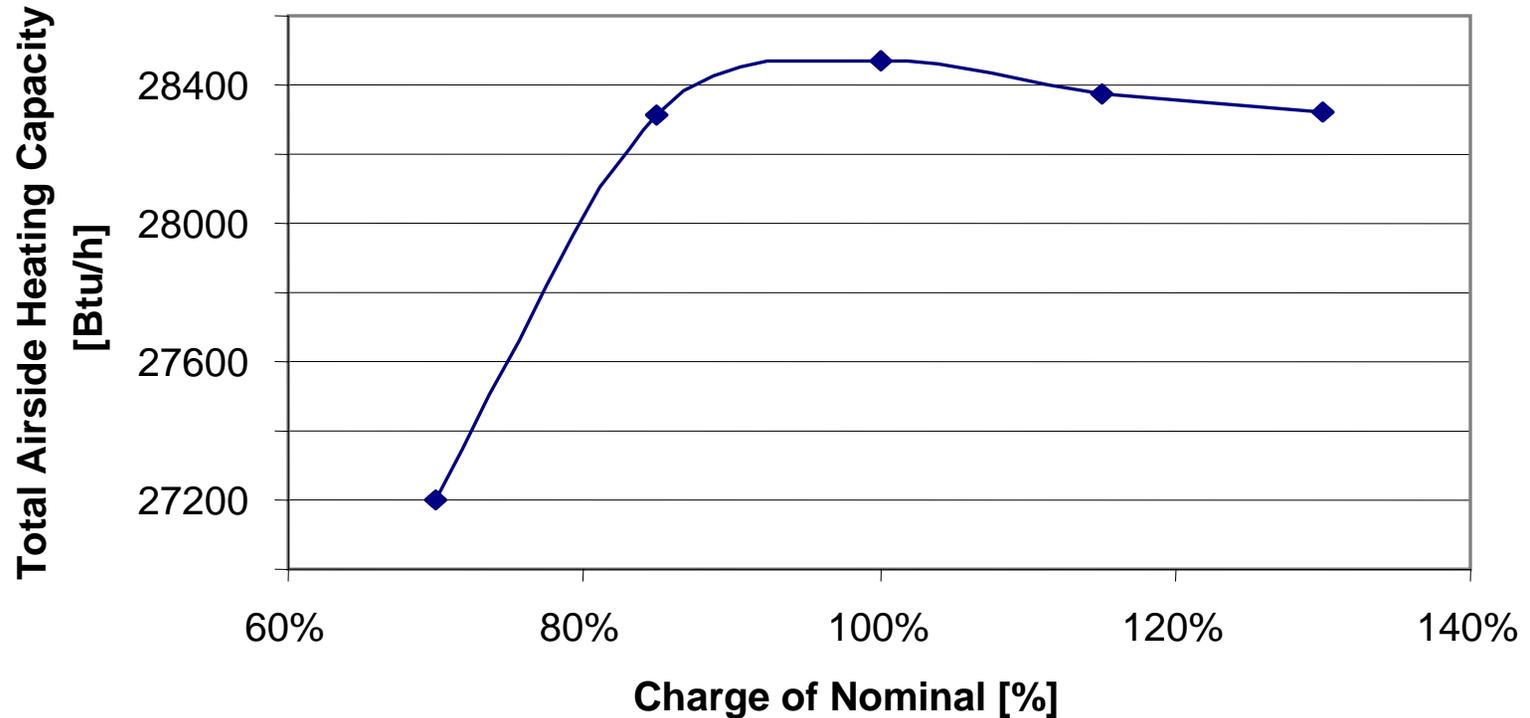
COP versus Charge Mass

(outdoor temperature of 35 °F & indoor flow rate of 1300 CFM)

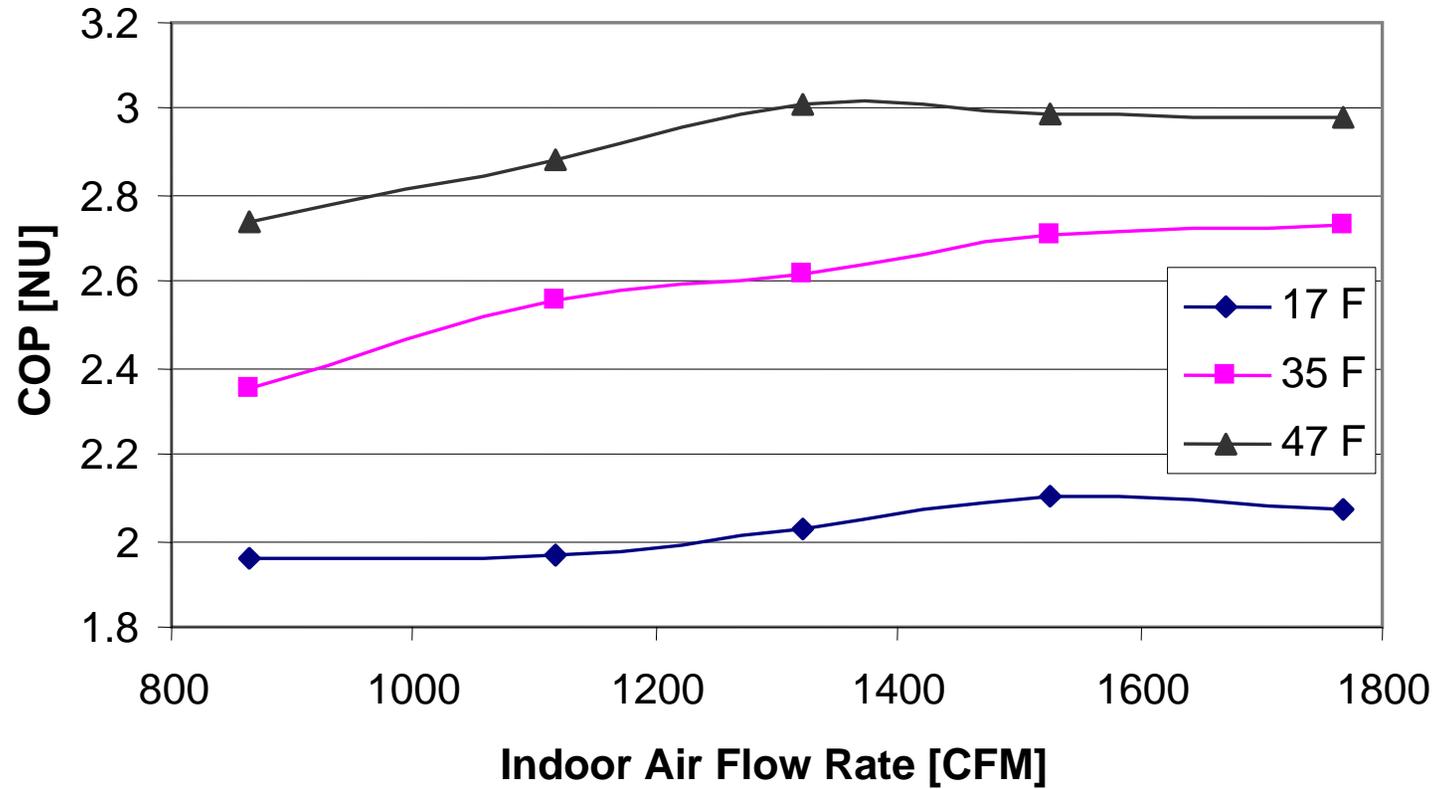


Heating Capacity versus Charge Mass

(outdoor temperature of 35 °F & indoor flow rate of 1300 CFM)

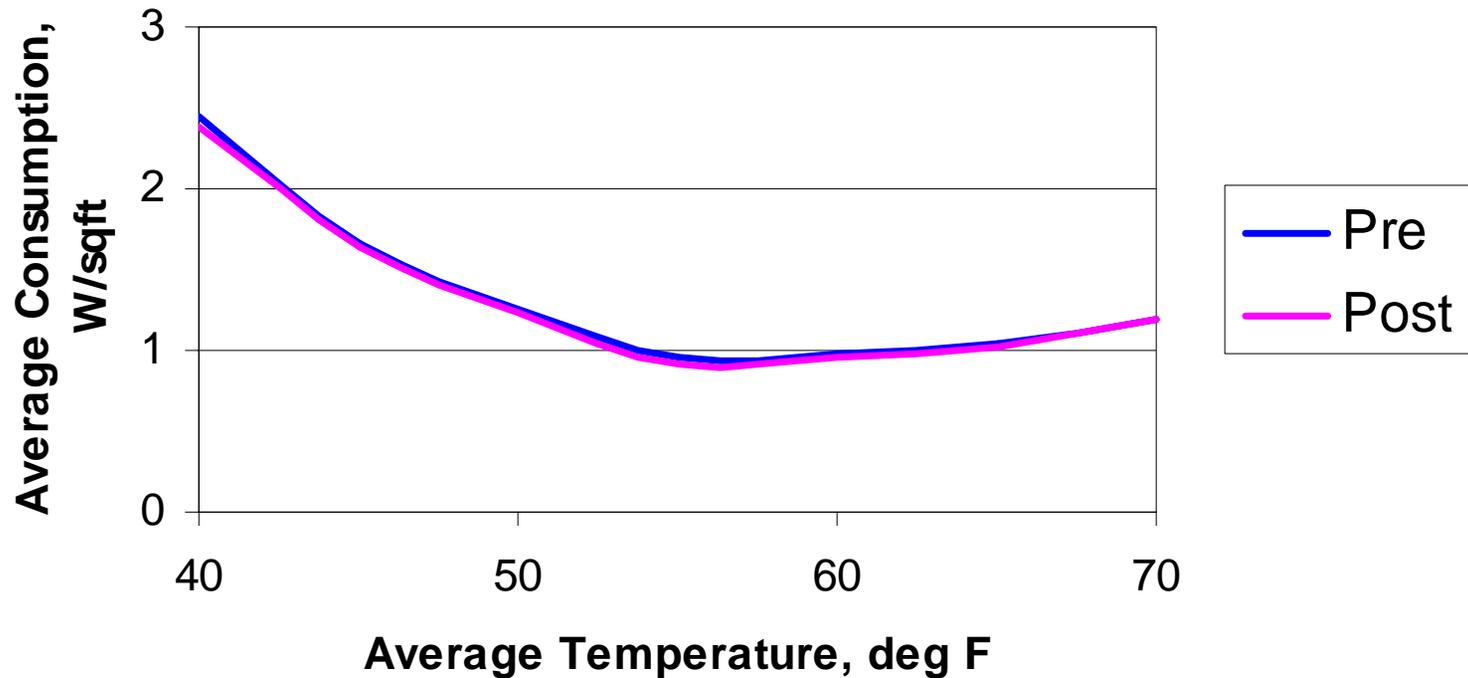


Impact of Airflow



Billing Analysis: CheckMe!

Pre/Post Operations Profile, n = 322

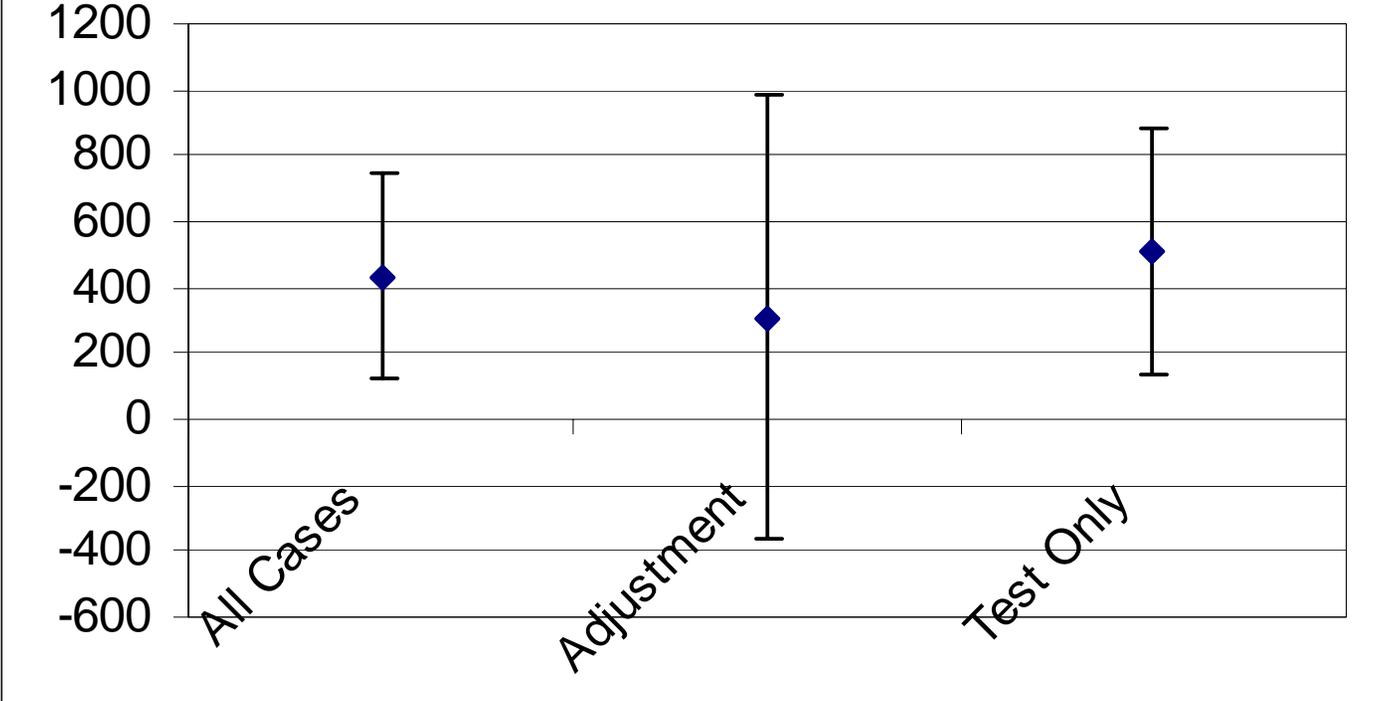


CheckMe![®] Analysis

- Analyzed homes receiving CheckMe![®] with and without charge adjustment
- Sample developed from homes commissioned through EWEB program
- Billing analysis performed on 600 homes, with complete data for modeling available for about half of the homes.

CheckMe![®] Program Savings

**Average Program Savings
with 95% Confidence Limits**



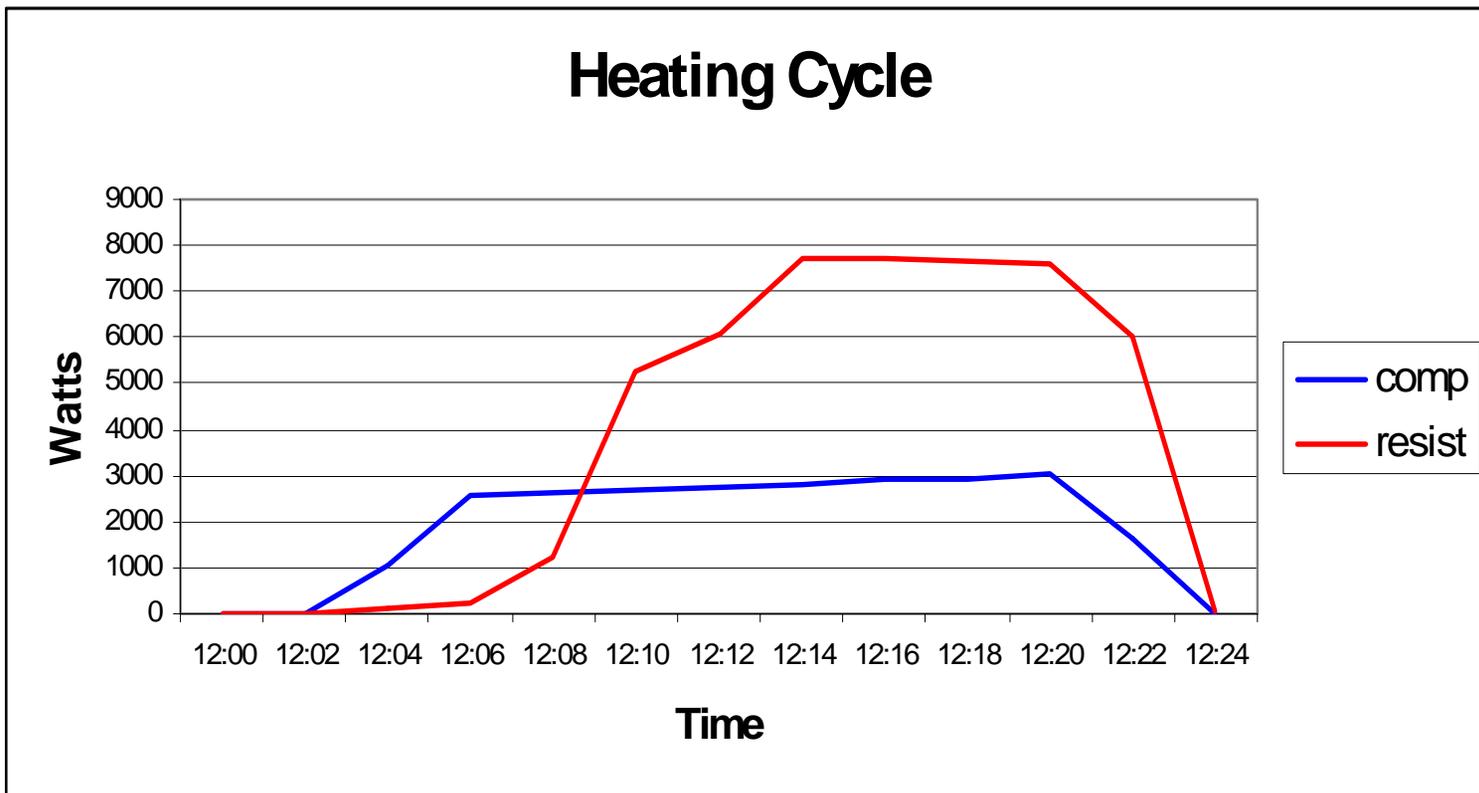
CheckMe![®] Analysis Results

- Gross savings average about 400 kWh per year.
- Savings distributed throughout the sample (both controls and charge-tested homes)
- No apparent benefit for refrigerant adjustment.
- Savings primarily from 8% of cases
- To do – verify savings estimate against control group

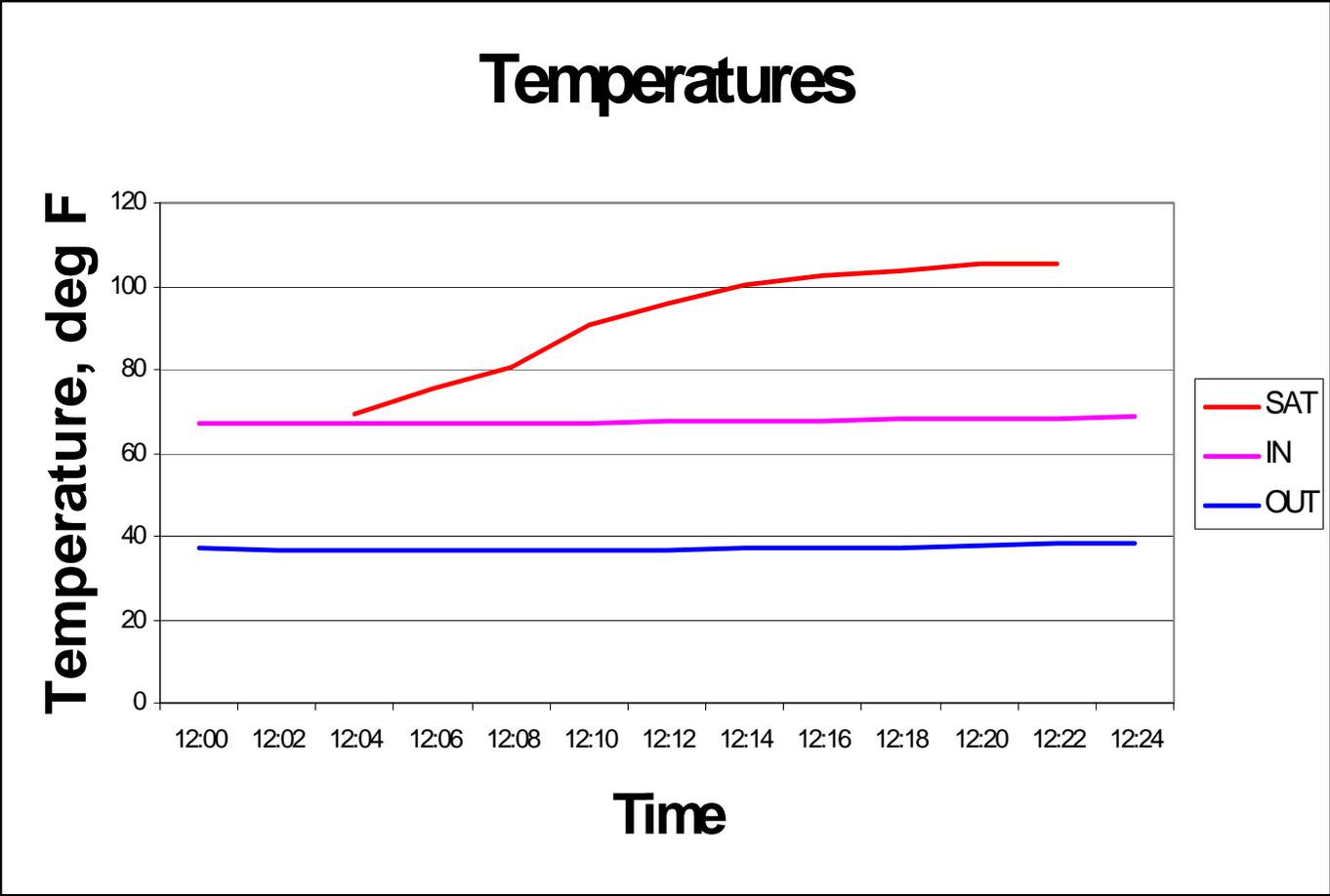
Field Site Monitoring

- 5 sites monitored since August; only 1 site operational early enough to capture significant cooling
- Extensive data required to exercise all the heating events (staged compressor, resistance, defrost)
- At several sites, performance problems were identified and controls were restored to proper operation

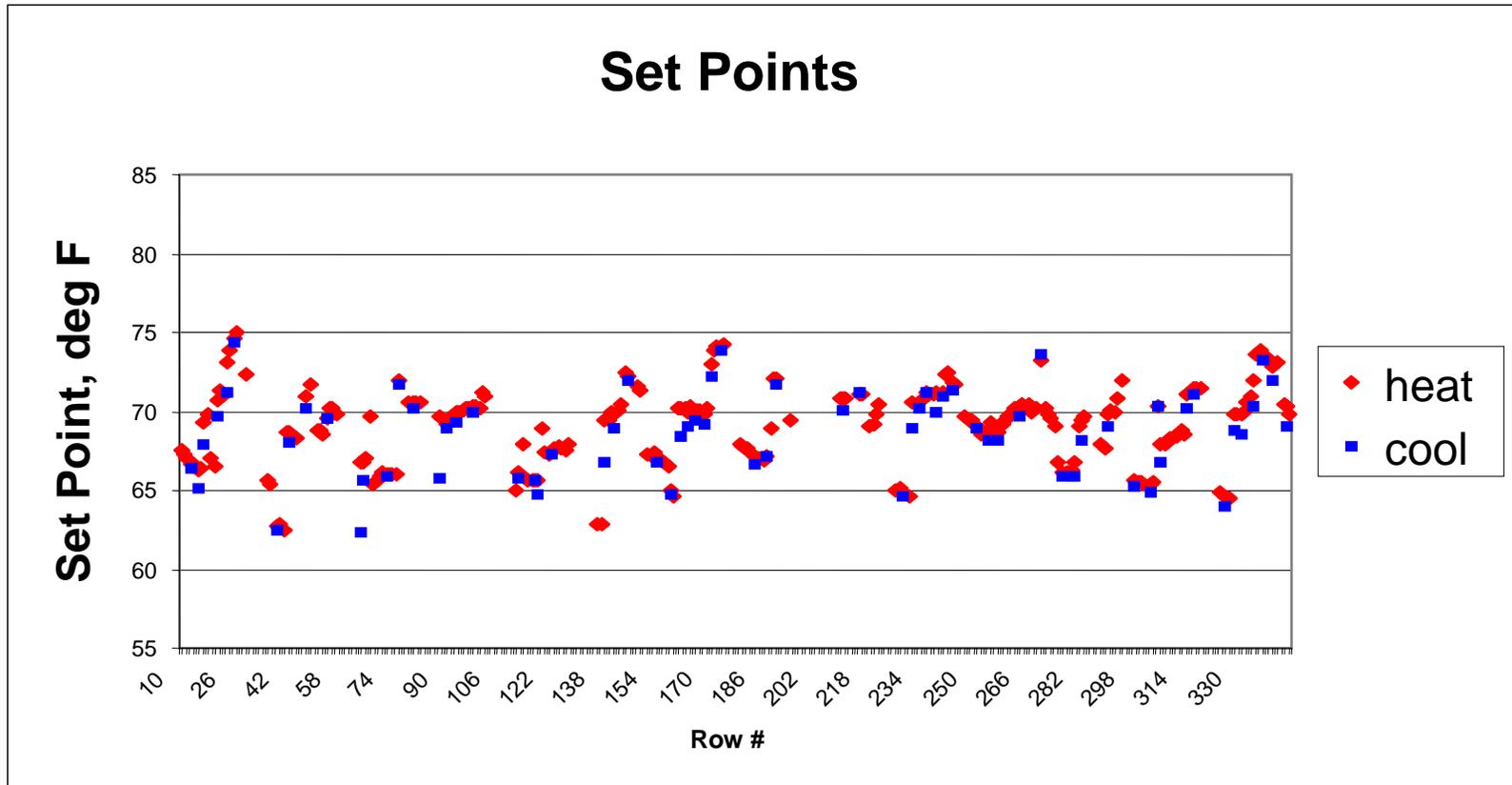
Typical Heat Pump Operation



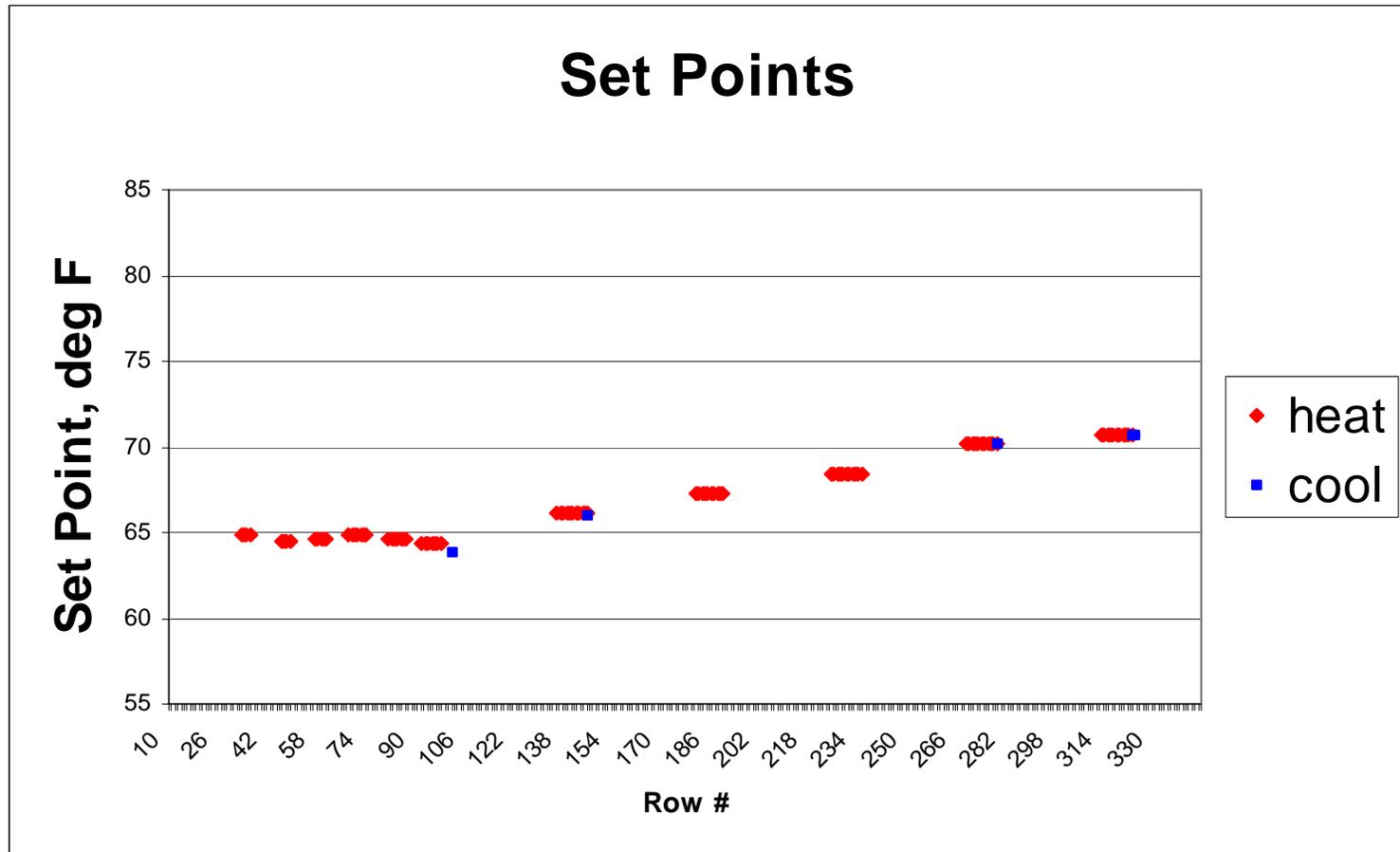
Typical Operation



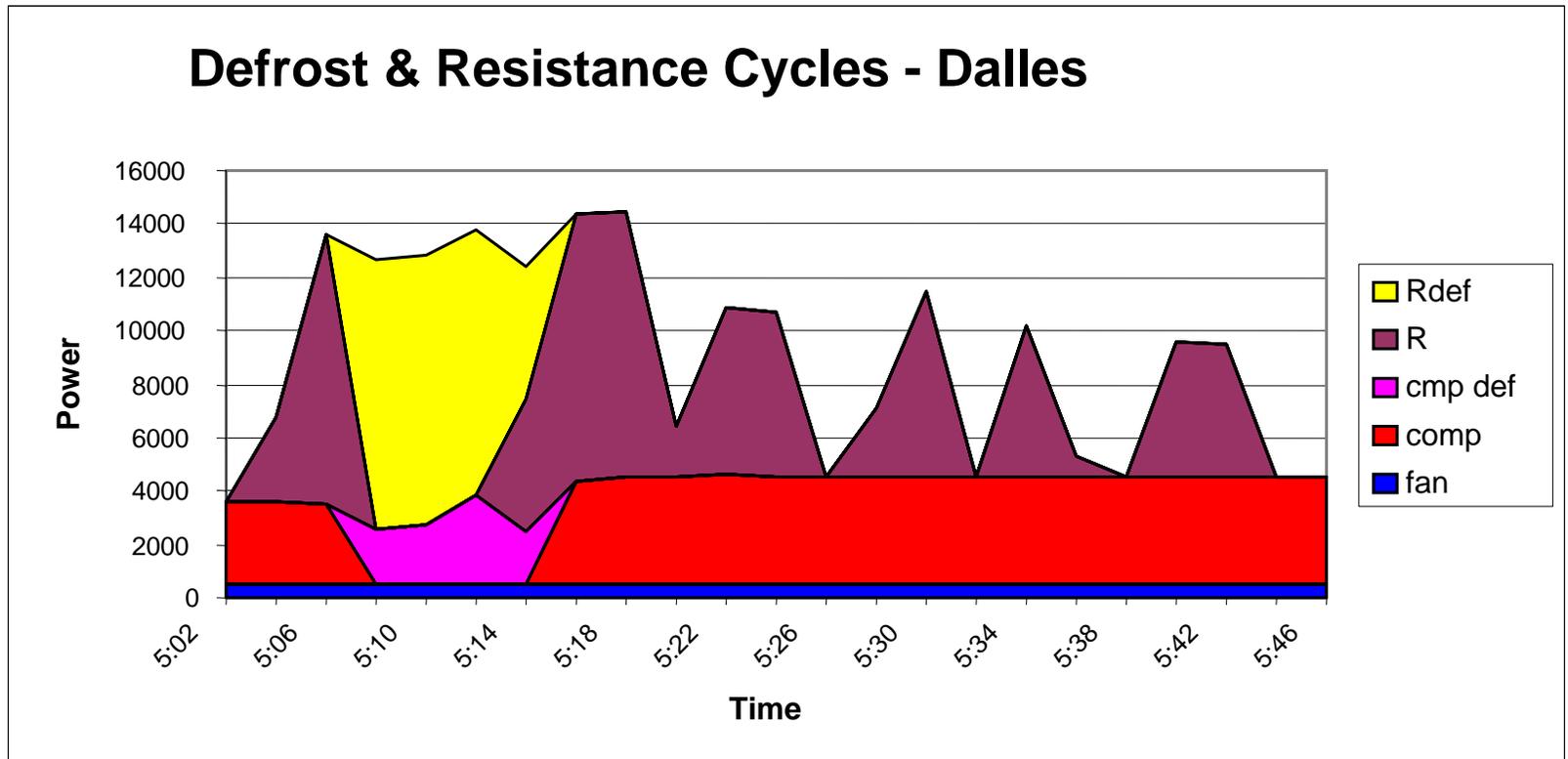
Frequent Change of Thermostat - The Dalles Site



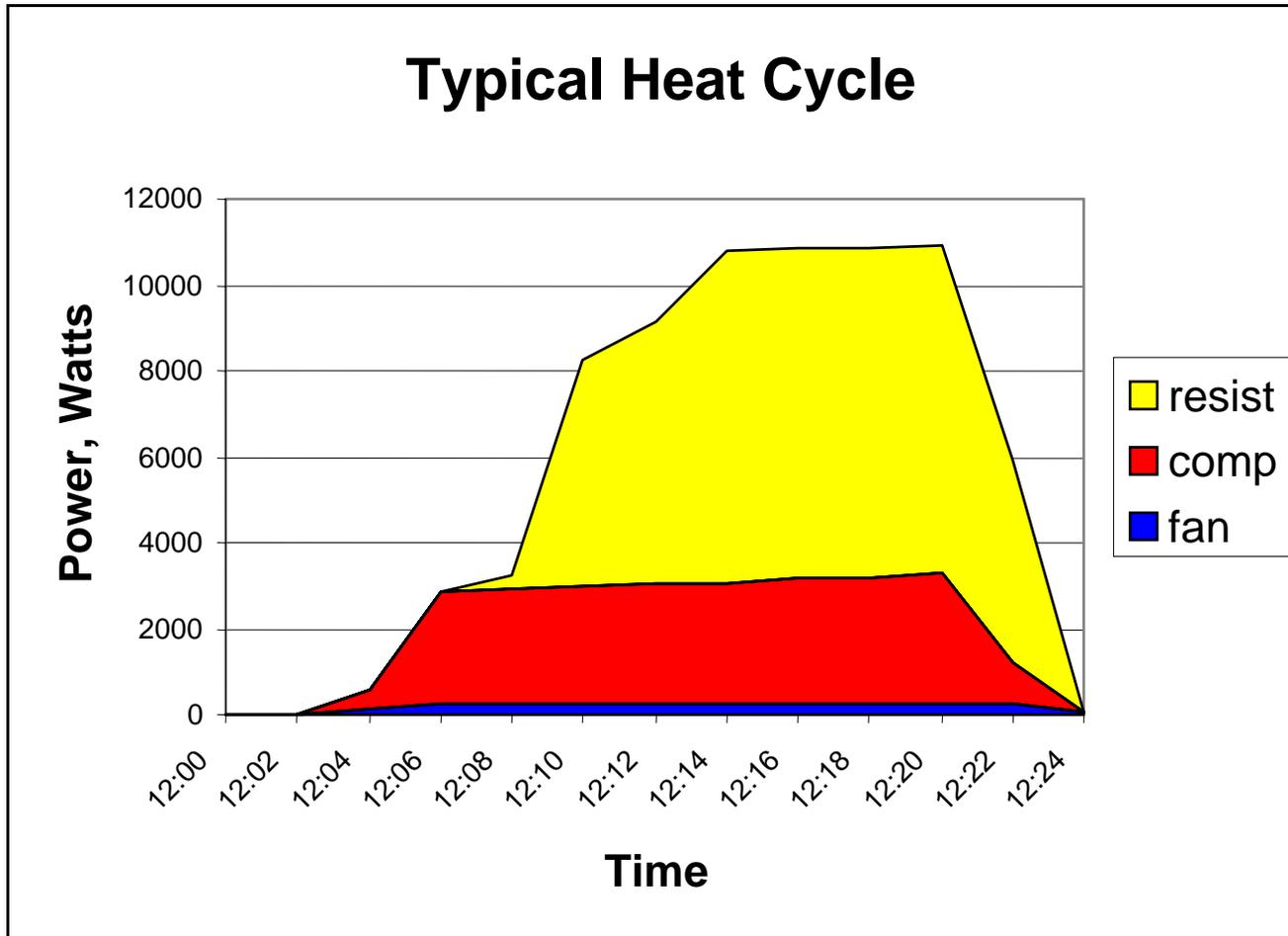
Improvement with Programmable Thermostat - The Dalles Site



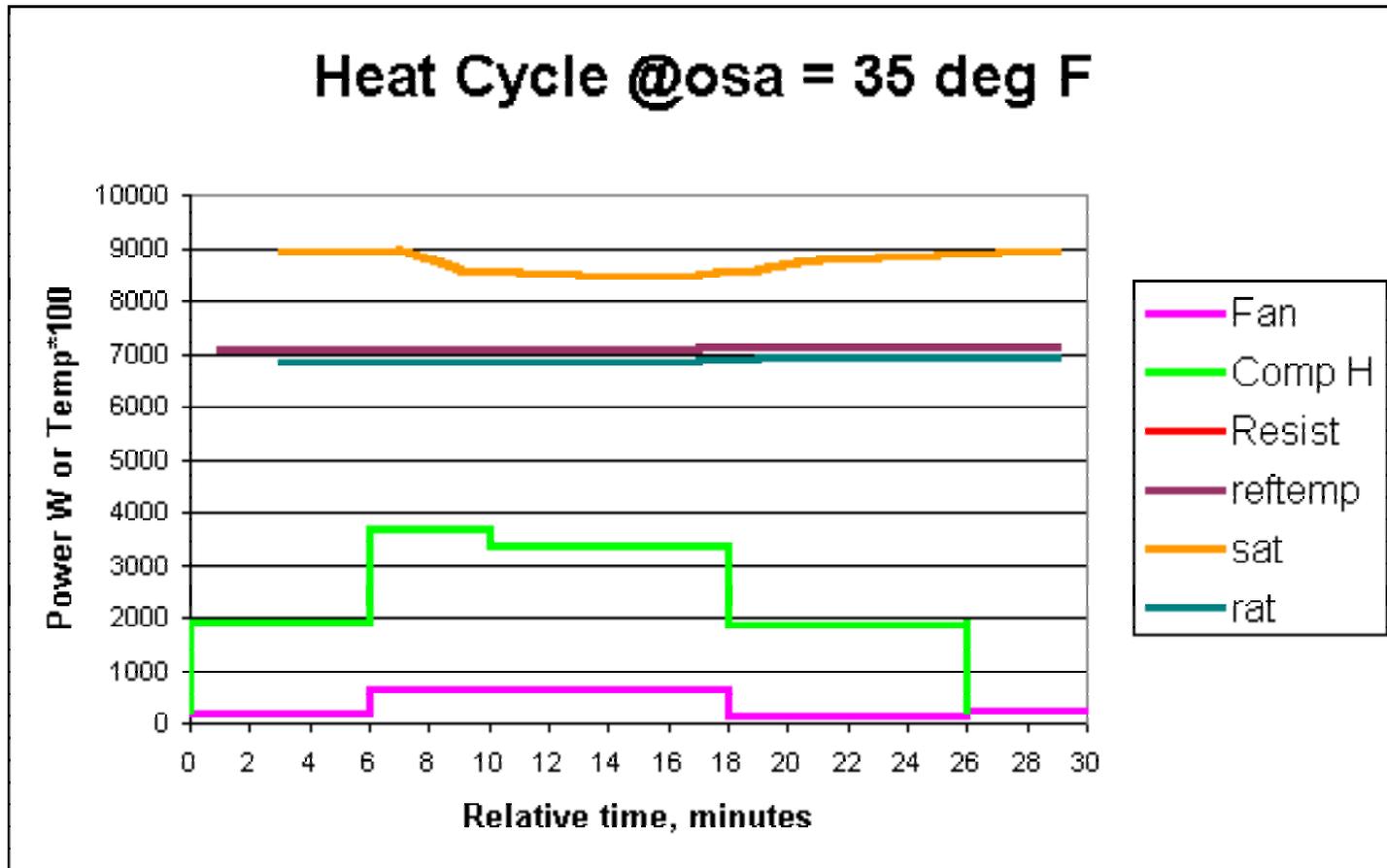
Typical Operation -The Dalles Site



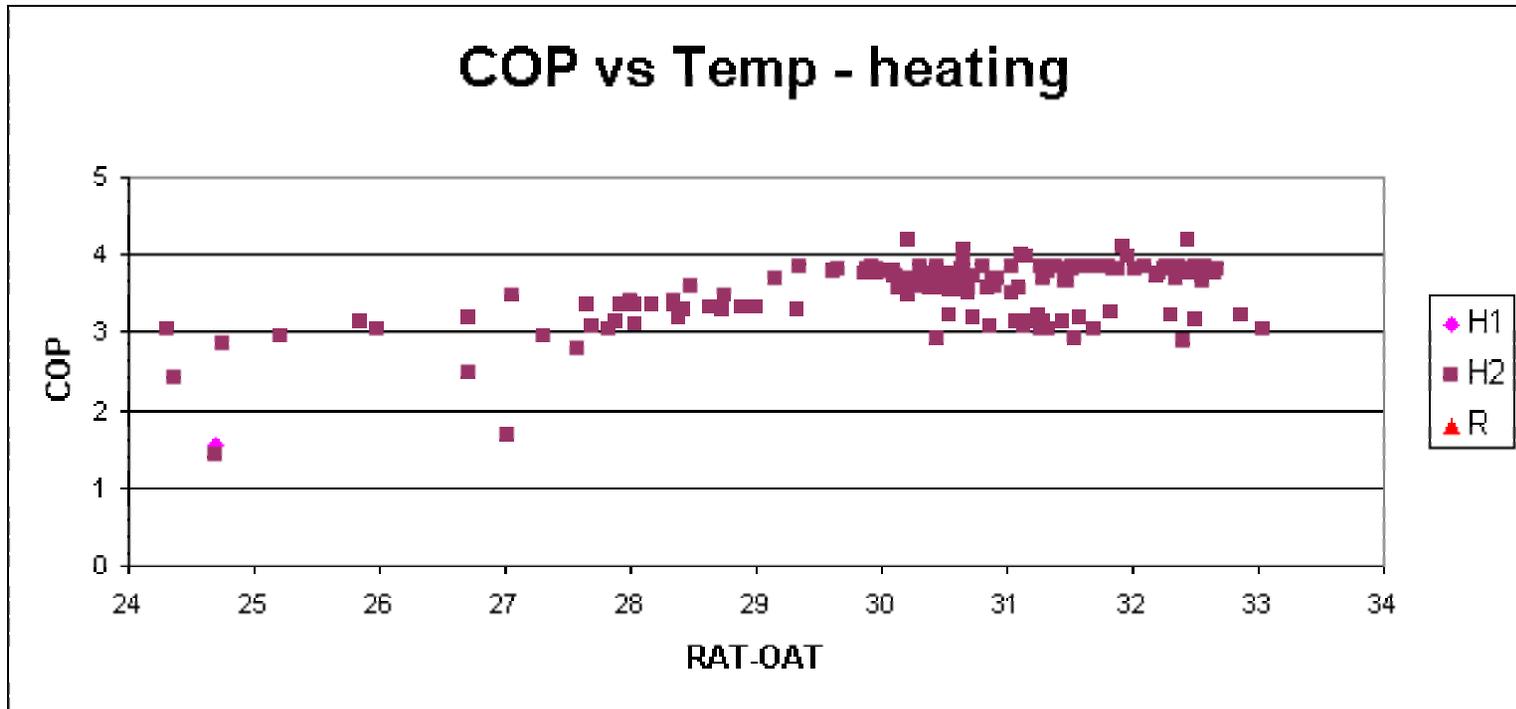
Typical Operation - Sunriver Site



Excessive Fan Operation



Fan and Compressor Stages Not Always Compatible



Overall Site Monitoring Results

Site	Heat 1 COP	Heat 2 COP	Resist COP	Melded COP
The Dalles	2.1	None	1.03	1.54
Sunriver	2.4	None	1.15	1.32
Eugene	3.1	2.1	nil	1.94
Ashland	3.2	3.7	nil	3.22

Regional Billing & Field Review

- Participants recruited from C&RD / ConAug utilities
 - Billing data from 2001-2004
 - Measure description
- Controls recruited from matched regions
 - Phone survey
 - Billing analysis
 - Field survey

Recruitment Results

Region	Participant Bills		Control Group		
	Estimated	Received	Bills Recd.	Field Review	HP Review
Tri-Cities	584	360	168	40	3
Coast/NW	1,002	581	248	40	8
Portland/Columbia	272	161	209	31	0
Central	272	0	144	38	13
Dropped	240	N/A	N/A	N/A	N/A
Total:	2,370	1,102	769	149	24

Regional Billing Analysis

- About half of collected data has been entered in database and preliminary analysis has begun
- Prism[®] found to be ineffective – too many outlier observations and use of cooling
- Applied pooled regression technique with good results
- Individual case review, more time-consuming than Prism[®] but less than *EZSim*[®]
- Analysis results available in March, 2005

Field Reviews

- Reviewed heat pump settings & operation, house configuration & duct efficiency
- Approximately 149 out of 160 homes reviewed
- Database design complete
- About half of completed surveys have been entered into database
- Analysis to begin by March, 2005

Market Actor Interviews

- Approximately 75% complete
- Early results