Review of Grocery Store Refrigeration Measures and Recommendations for NRM CoolTrol Proposal

Presented to the

Regional Technical Forum

February 7th, 2005

Introduction

- Request from National Resource Management for RTF approval of “CoolTrol” system.
- Review of Grocery Refrigeration Efficiency Measures
- Recommendations


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Efficiency Measures - *Controls*

- Energy Management Systems
- Anti-sweat heater controls
- Defrost controllers
- Floating head pressure controls
- Beverage case controllers
- Vending machine controllers

Efficiency Measures - Equipment

- Fan motor upgrades (ECM)
- “No Heat” glass doors
- Hot gas defrost
- Condenser improvements
- Water cooled condensers
- High efficiency lighting

Efficiency Measures - *Equipment*

- Multi-plex compressors
- Efficient/oversized air-cooled condensers
- Replace open case with reach-in
- Replace self-contained cases with remote-compressor case

Efficiency Measures – *O&M*

- Strip curtains
- Night covers
- Door Gaskets
- Suction line insulation

Best Candidates for Deemed Savings or Calculators

1. Refrigeration Energy Management Systems
2. Evaporator fan controllers
3. Anti-sweat heater controllers
4. Fan motor replacement (ECM)
5. Self-contained beverage cooler controllers (timeclock)
6. Case lighting upgrades


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Evaporator Fans

- Evaporator fans provide forced air circulation across refrigeration coils.
- Evaporator fans typically have propeller fans and fractional HP motors that usually run continuously.

Evaporator Fan Controls

- Controllers stop or reduce fan speed when compressor cycles off.
- Most economic in larger walk-in coolers and freezers.

Evaporator Fan Controllers – Example Products

- National Resource Management, CoolTrol (see handouts
- ENS Fan Saver (see handout)

Evaporator Fan Controls – *Energy Savings*

- Reported savings typically range from 10% to 60% of evaporator fan energy
- Savings definitely vary by project
  - Factors: Compressor ON time & fan power
- NRM proposes 27% as a conservative value. (82 to 234 watts x (8,760) x 0.27 /1,000 = **193 to 553 kWh/yr per fan**)
- California Express Efficiency uses **1,109 kWh/year per fan**

Evaporator Fan Controls – *Economics* (For 6 fans)

Savings Example (Source: EnergyIdeas Clearinghouse)

Compressor Run Time	Annual kWh Savings	Dollar Savings	Payback (Years)
20%	6,189	$309.47	1.9
40%	4,642	$251.45	2.4
60%	3,095	$154.75	3.9
80%	1,547	$77.37	7.8

Evaporator Fan Controllers - *Economics*

- Cost
  - Stand-alone controller, $100-$600
  - Energy Mgmt System, $3,000 - $6,000
- Utility Incentives
  - California Express Efficiency Rebates, Southern California Edison - $75/controller
  - NSTAR, 80% of cost plus financing
  - California SPC, $0.20/kWh (typically 75% to 100% of cost)
  - National Grid, 80% of cost plus financing
  - Oregon Trust, 35% of cost plus BETC

Evaporator Fan Controllers - *Issues*

- Savings depend on compressor duty cycle, but compressor duty cycle varies greatly
- Savings vary by season, short-term test of compressor duty cycle may be seasonally biased
- Some methods of determining fan motor power (kW) may be unreliable
- Compatibility with ECM motors
- Persistence of savings (owner acceptance, technical problems)

Anti-Sweat Heaters

- Anti-sweat heaters are used to prevent condensation on glass doors and frames.
- **Baseline**: Anti-sweat heaters are resistive loads that *usually* run continuously.

Anti-Sweat Heater Controllers

A number of products available.

- Controllers cycle heaters:
  - On/Off
  - Pulse Modulation
  - Voltage Reduction
  - Amperage Reduction
- Based on:
  - Humidistat
  - Dew point sensor
  - Moisture sensor

Anti-Sweat Heater Controls - *Products*

Some product examples:

- Door Miser
- NRM CoolTrol
- Invensys Com-Trol
- Emerson E2 with PMAC II

Anti-Sweat Heater Controls - *Economics*

- Savings can range from 25% to 80% of connected load, plus some refrigeration savings.
  - 300-400 kWh per linear foot case
  - 800-1000 kWh per door
  - 13,000 kWh for an 11-door walk-in (6 fans)
- Lower savings for freezer doors
- Typical cost about $85 per door (Source: Wisconsin Focus on Energy).

Anti-Sweat Heater Controls - *Economics*

- Typical Payback 0.5 to 3 years
- Utility Incentives
  - Southern California Edison - $14/LF
  - Wisconsin Focus on Energy - $10/door
- Savings
  - Express Efficiency – Deemed at 343 kWh/ln ft, or 851 kWh/door

Anti-Sweat Heater Controls - *Issues*

- Some existing anti-seat systems may be inoperative or already controlled.
- Determining connected kW may be difficult.
- Short term metering may not capture ambient humidity variations, especially summer/winter differences.

ECM Motors

(Electrically Commutated Motors)

- Replacement for shaded-pole and permanent split capacitor (PSC) motors in evaporator fans.
- Savings
  - Typically 40% to 65% savings
  - Annual savings less with evap. fan controllers
  - Additional refrigeration savings from reduced waste heat.
  - Energy Smart Grocer: 920 kWh/yr per motor
  - NRM: 630 to 1,072 kWh/yr per motor

ECM Motors
(Electrically Commutated Motors)

- Issues
  - Technical issues in refrigeration case applications have caused redesign of early models
  - Potential compatibility with pre-existing fan controllers
  - Relatively expensive ($250-300/fan)
  - Annual savings drop with fan control measure

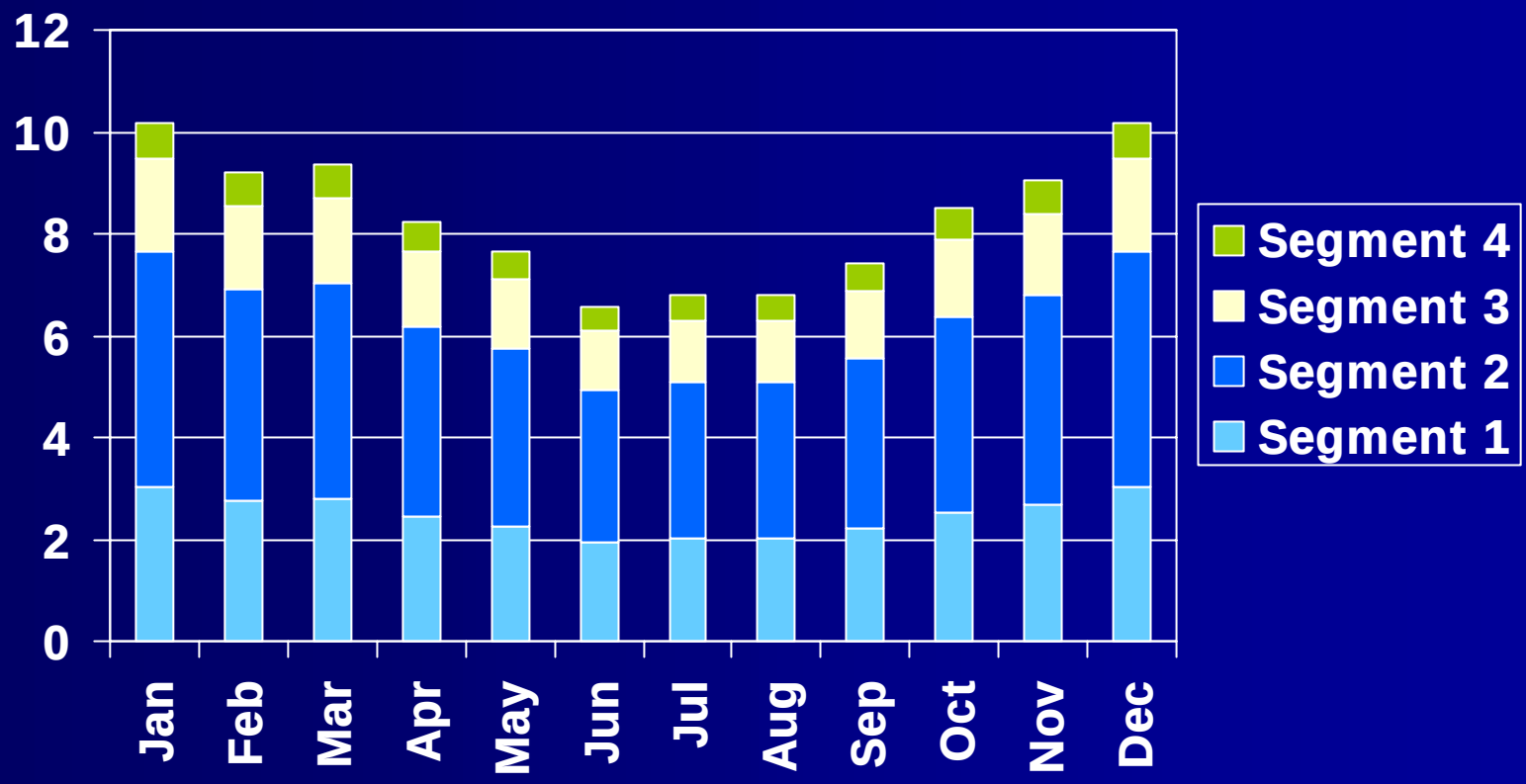
Measure Interaction

- NRM CoolTrol is an Energy Management System for Walk-Ins
- Mix and Match Multiple Measures
  - Evaporator Fan Control
  - Door Heater Control
  - ECM Motors
  - Web enabled for remote diagnostics, monitoring, control reset, alarms and data logging
- Auditors identify & recommend options

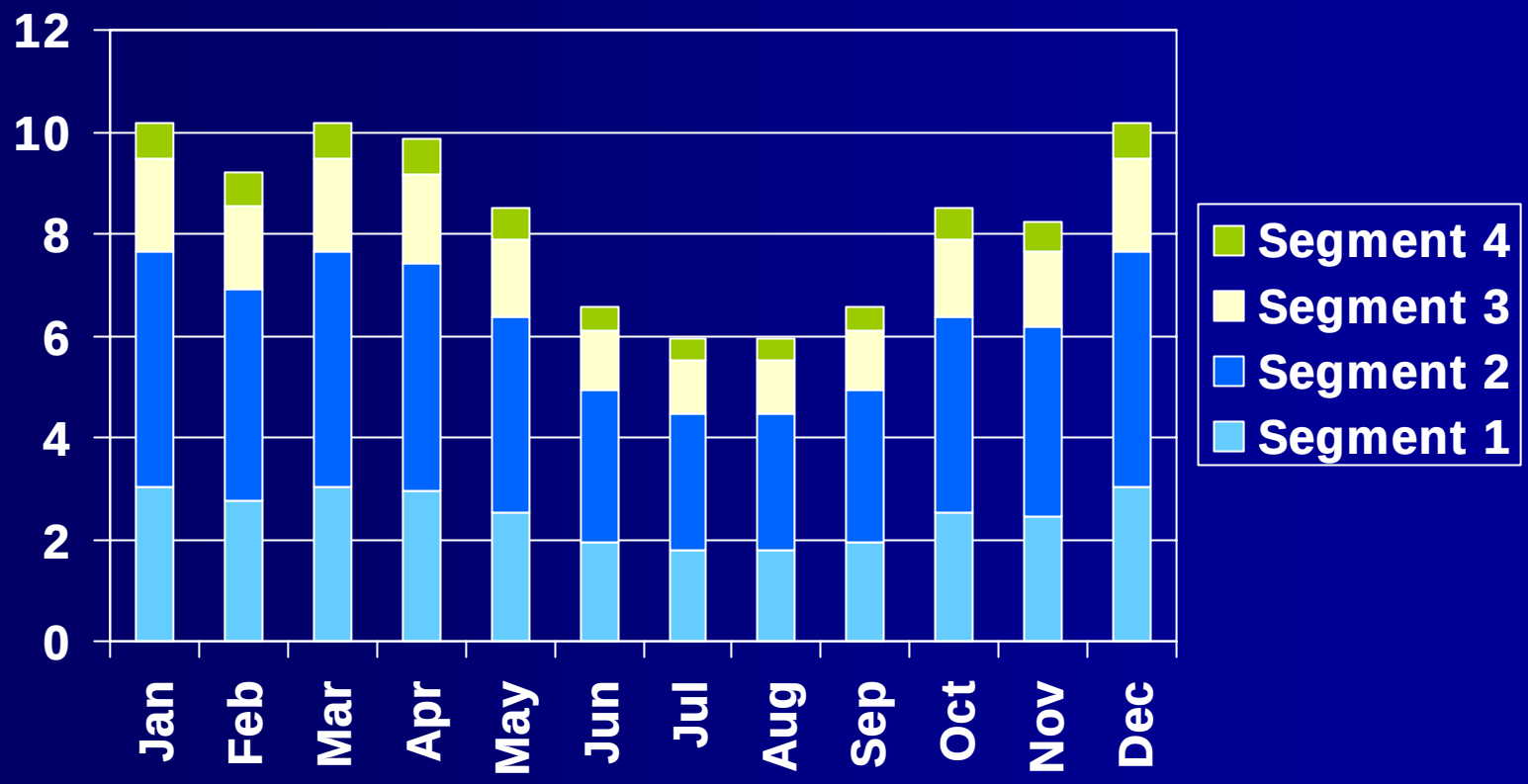
Cost-Effectiveness

- Shape and value of kWh & kW savings
  - Preliminary from data loggers
- Life of Savings
  - 8 Years Control, 12 Years Motors
- Non-Energy Benefits not quantified
  - Alarms, monitoring, diagnostics, & remote control
  - Significant durability of savings benefits from web-enabled monitoring
  - Product quality benefits with alarms (save the ice cream)
  - No data on frequency or value of NEB

Shape of Fan Controller Savings

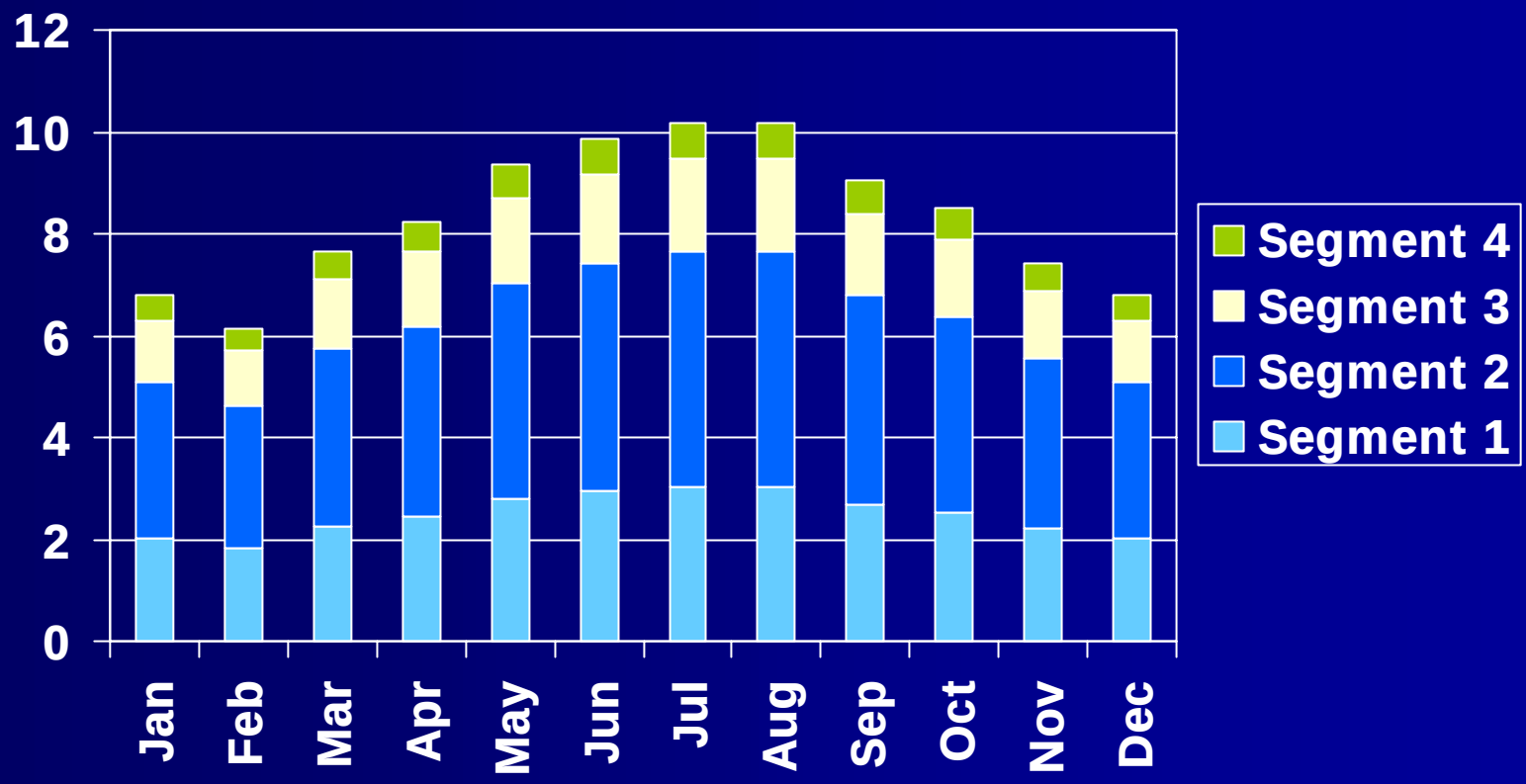


Shape of Door Heater Controller Savings



Shape of ECM Motor Savings

With Fan Control



Components of Typical NRS Retrofit

- CoolTrol System
  - Evaporator Fans
  - Temperature
  - Anti-sweat heaters
  - Defrost cycle
  - (HVAC Economizer)
- ECM Motors
- Proposed Calculations (see handout)
- (Remote Site Manager)

Example CoolTrol EMS Package
(Plaid Pantry Store in Portland, OR)
(Total of 6 fans and 11 doors)

Equipment	Energy Savings (kWh)	Demand Savings (kW)	Cost ($)	Benefit/ Cost Ratio
Fan Control	5500	1.1	1800	1.0
Door Heater	12,700	2.6	1100	3.7
ECM w/ fan control	4100	1.0	1700	1.1
Combined 3-Measure	**22,300**	**4.6**	**4600**	**1.7**

Cost-Effectiveness Issues

- Probably a minimum size threshold
  - Significant first cost for controller
  - Smaller incremental cost for additional control features
  - Probably not cost-effective for small 2-fan Walk-In with no door heaters (eg restaurant)
- Require Project Minimums?
  - Minimum total fan power (watts)
  - Minimum controllable door heater demand (watts)
  - Two-measure minimum: Door heater plus fan control, or door heat plus ECM motor
  - ECM motors where post-control fan hours are high
  - Minimum B/C ratio

C&RD Credit Calculation Options

A. Establish Deemed Value by item
B. Develop Simple Generic Calculators
C. Accept NRM site-specific calculations, with qualifications

Evaporator Fan Control Savings Calculator

Baseline	
Connected Fan Power (kW)	4.3
Annual Run Hours	8760
As Installed	
"Off" Period Fan Power (kW)	0
Annual Hours Off	3504
Savings	
Percent Savings	60%
Annual kWh Savings	**15,067**

Recommendations

A. Accept NRM site-based calculations (see handout), with the following qualifications
   1. Assume 8 year measure life.
   2. Require minimum project size (e.g 3 kW of controlled loads).
   3. Require metered data on first 10 projects (7-day A/B test). Include winter and summer monitoring.
   4. Revise credit as indicated after completion of first 10 projects.

Recommended Next Steps

A. NMS CoolTrol
   1. Review existing program evaluations
   2. Identify minimum project specifications, data monitoring & evaluation requirements

B. Develop Deemed Savings for stand-alone controllers
   1. Walk-in Evaporator Fan Controllers
   2. Anti-Sweat heater controllers
   3. ECM Motors

C. Consider Energy Smart Grocer Program