Benchmarking Industrial Refrigeration Systems

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Overview

- Benchmarking Concepts and Principles
- Preliminary Data
  - Refrigerated Warehouses
  - Bulk Storage Facilities
  - Dairies
- Next Steps

Benchmarking – A Management Tool

Benchmarking process:

- Define appropriate measures of performance
- Measure your own performance
- Compare to the benchmark
- Take steps to close the gap

Benchmarking – Why Do It?

- Find out where you stand
- Identify opportunities for improvement
- Track the effects of system changes
- Increase your competitiveness

Benchmark

The Benchmark is a standard for comparison. It may be:

- Performance of a "*best practice*" company
- Selected performance level from a sample of comparable plants
- Based on a theoretical ideal

Benchmarking Energy Use - Techniques

- Frequency distribution
- Regression analysis
- Model-based
- Points-based

Difficulties in Benchmarking Refrigeration Systems

- Every refrigeration plant is different
- Large samples are needed to make meaningful comparisons
- Data are not readily available

Benchmarking Energy Use – Existing Data

- DOE Commercial Building Energy Consumption Survey (CBECS)
- California commercial building benchmarking database (Cal-Arch)
- Sector-specific studies in UK and Canada

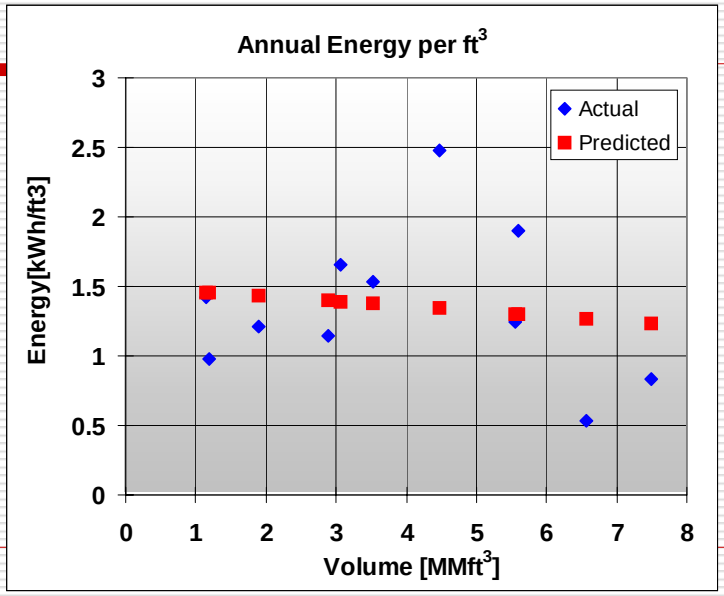
IRC Benchmarking Analysis - Preliminary Data

- Refrigerated Warehouses
- Bulk Storage Facilities
- Fluid Milk Plants

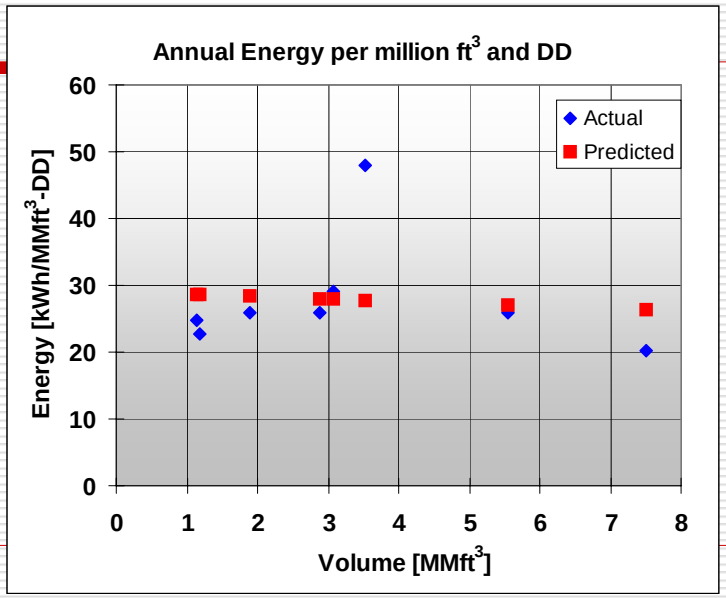
Refrigerated Warehouse Analysis

- IRC Data – Regression Analysis
- Simulation Model
- UK Study
- CBECS Database
- Cal-Arch Database

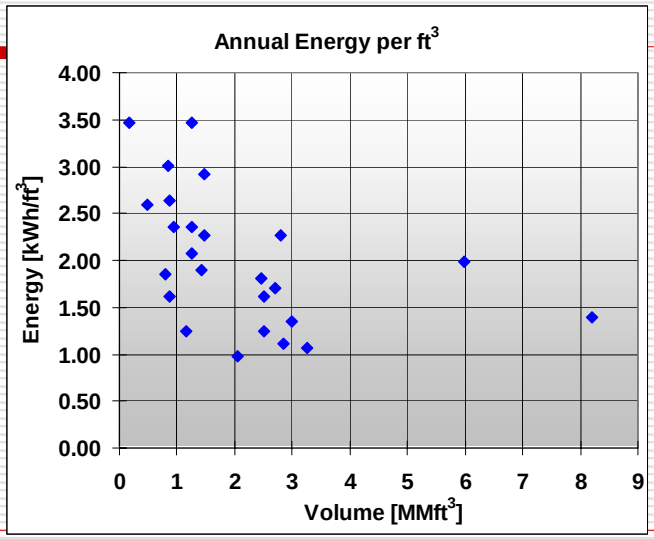
IRC Data – kWh/ft^3



IRC Data – kWh/ft^3·degree-day



UK Refrigerated Warehouse Survey



Reference: Best Practice Programme: Guide 37, Cold Storage Sector, UK Department of the Environment, 1994.

Refrigerated Warehouse Simulation

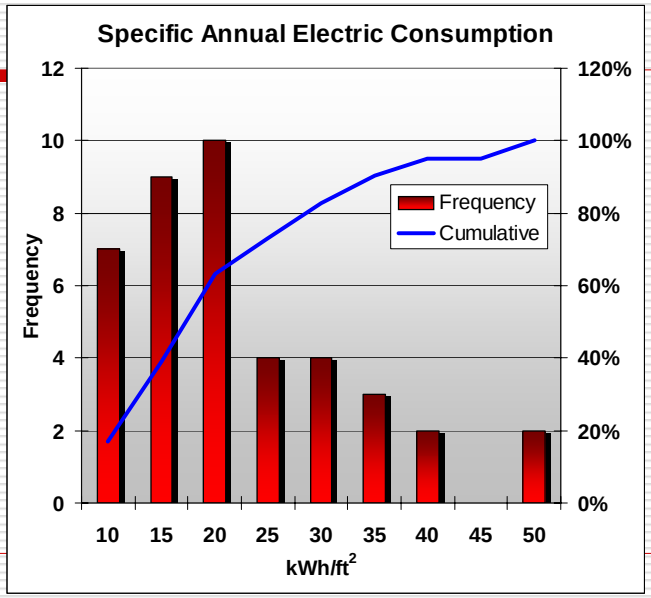
Typical frozen-food warehouse

- Upper Midwest location
- 100,000 ft^2
- Freezer at –20ºF, dock at 38ºF
- Lighting: 0.5 to 2.0 W/ft^2
- Product load: 50 to 400 klbs/hr, 10ºF dT
- Occupancy: zero to 96 hrs/week

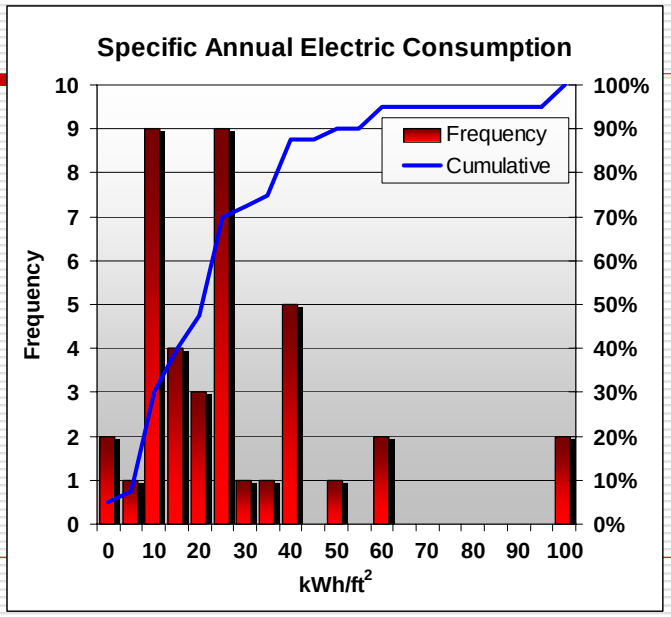
Simulation Results

	kWh/ft^3	kWh/ft^2
Typical	1.15	31
Maximum	1.41	38
Minimum	0.63	17

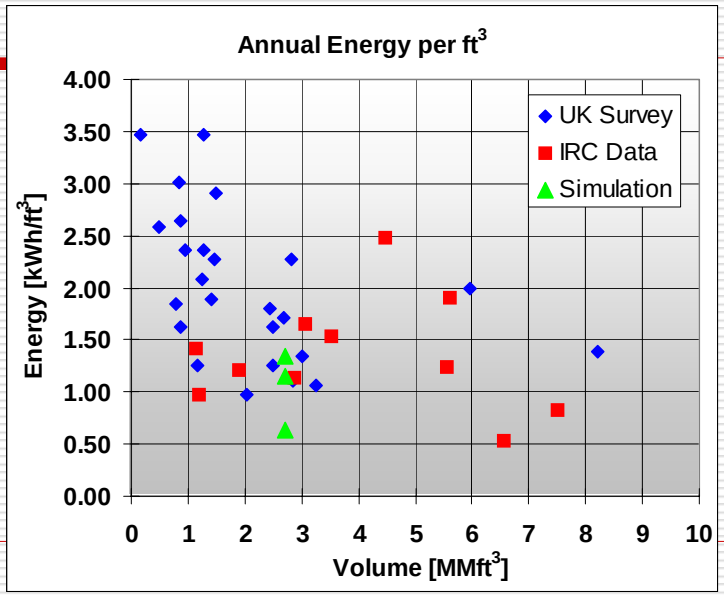
CBECS Refrigerated Warehouse Data



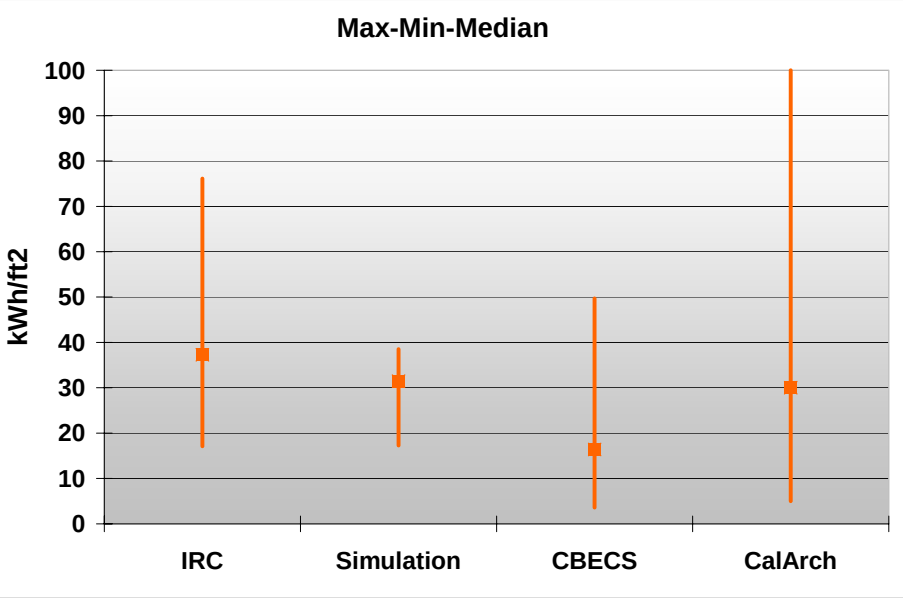
CalArch Refrigerated Warehouse Data



Warehouse Data Comparison



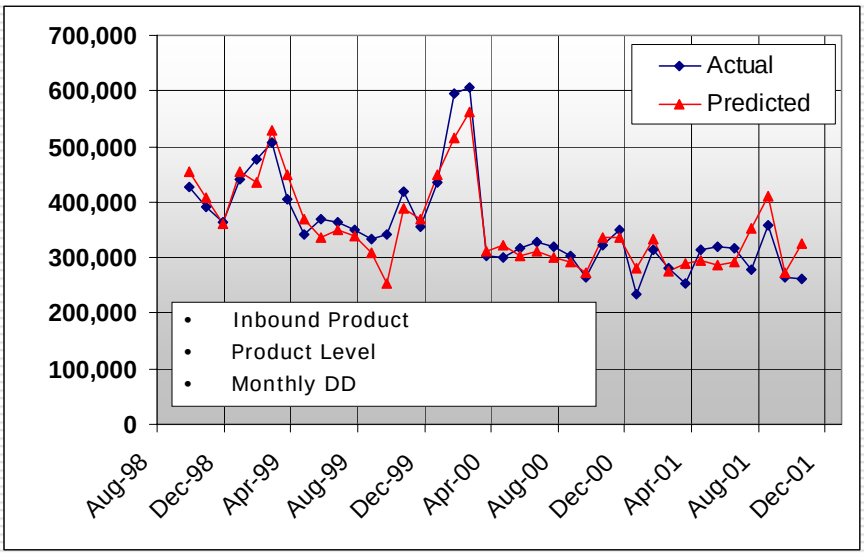
Warehouse Data Comparison



Bulk Storage Facilities

- 20 facilities
- Regression analysis
- Energy use correlated to throughput and weather
- Correlations not consistent among plants

Bulk Storage Facility

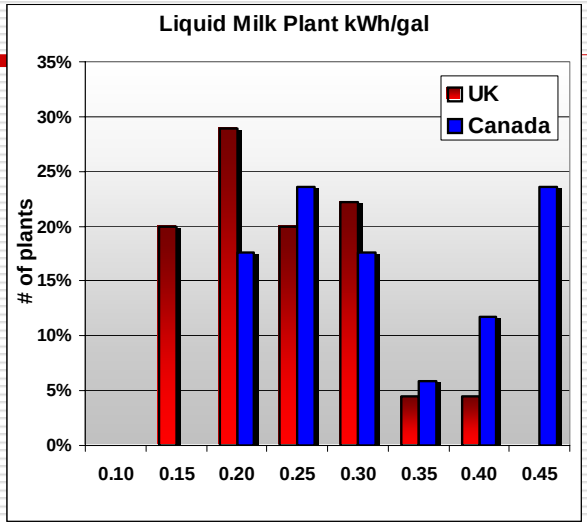


Fluid Milk Plants

There is some published data on this sector

- UK Study
- Canadian Study

UK and Canadian Dairy Plant Surveys



References: Energy Performance Indicator Report: Fluid Milk Plants. Natural Resources Canada. 2001.

The Liquid Milk Sector of the Dairy Industry. Energy Consumption Guide 26. UK Department of the Environment, ETSU. 1991.

Lessons Learned

- Data quality varies widely
- Data gathering effort may be significant
- Production data and energy data must cover the same periods
- Correlations may not be obvious

IRC Benchmarking – Next Steps

- Continuing to solicit participants
- Will use a simplified survey form
- Cooperating with a Midwest energy provider
- Cooperating with New Zealand researchers

Questions?