Residential and Small Commercial Furnace and Air Conditioner Performance Retrofit

Brushless Permanent Magnet Fan Motors

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BPM Retrofit Motors

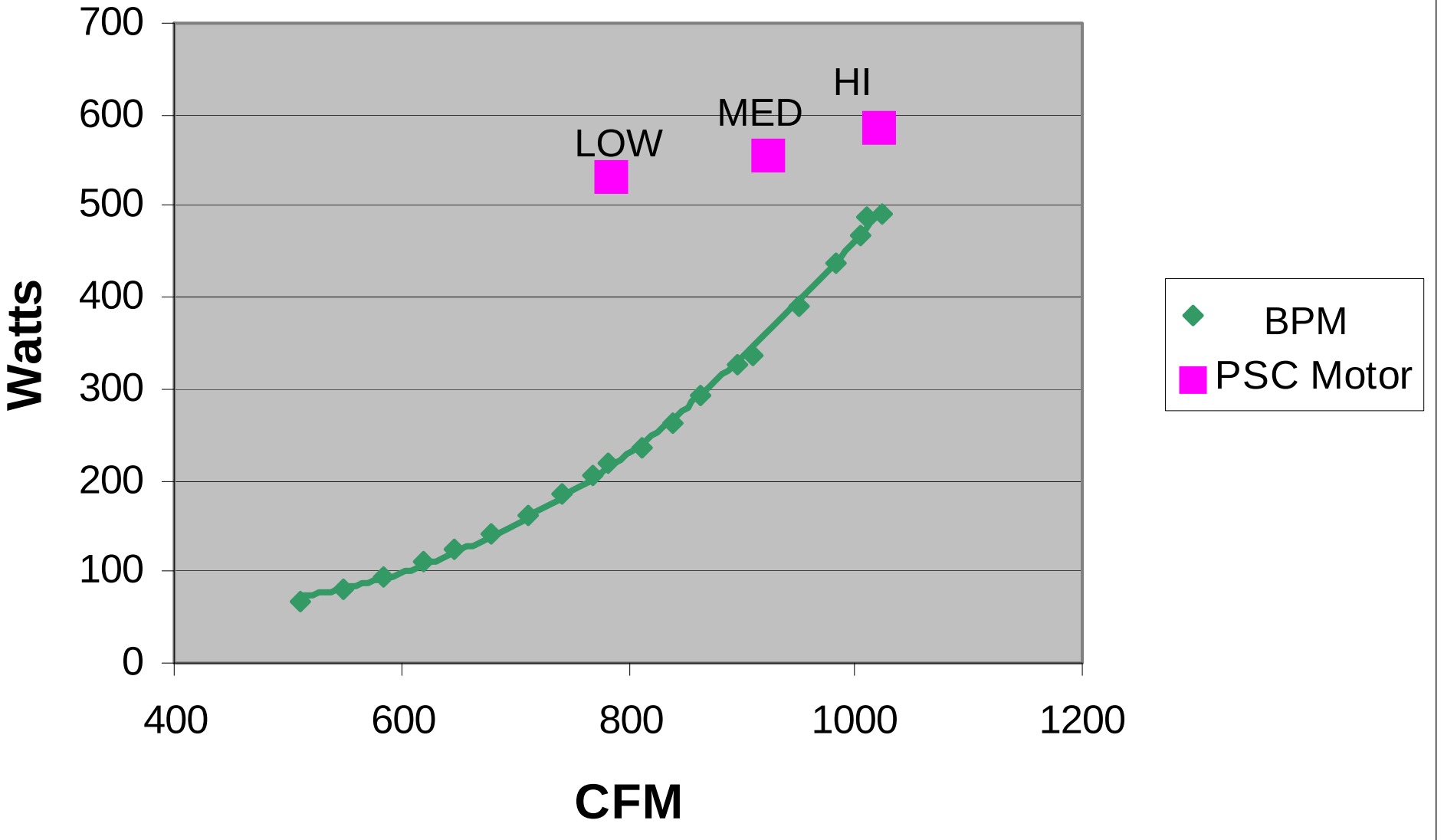
- Regal Beloit Evergreen™
- Emerson Eco-Tech™
- CheckMe! Concept 3®

Furnace/AC Fan Motors

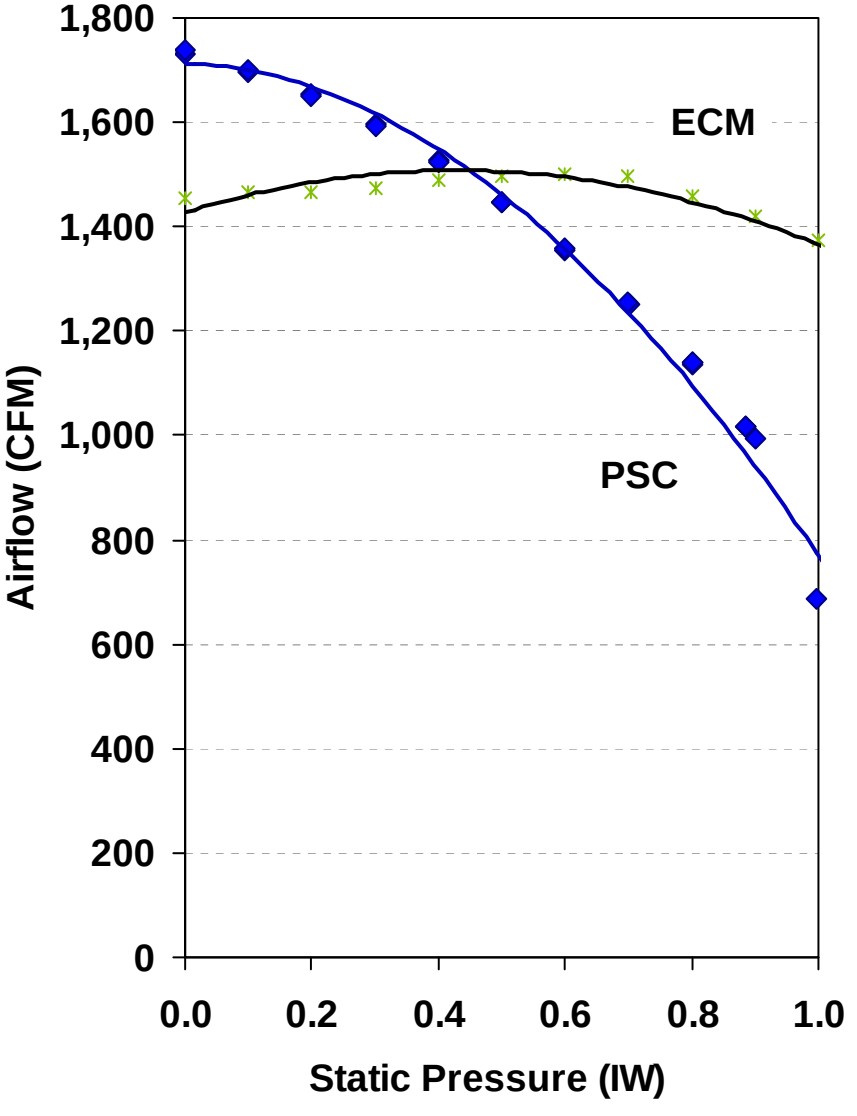
- Permanent Split Capacitor
  (Constant Wattage)
  - 95+% of furnaces
- Brushless Permanent Magnet
  (Variable Wattage)

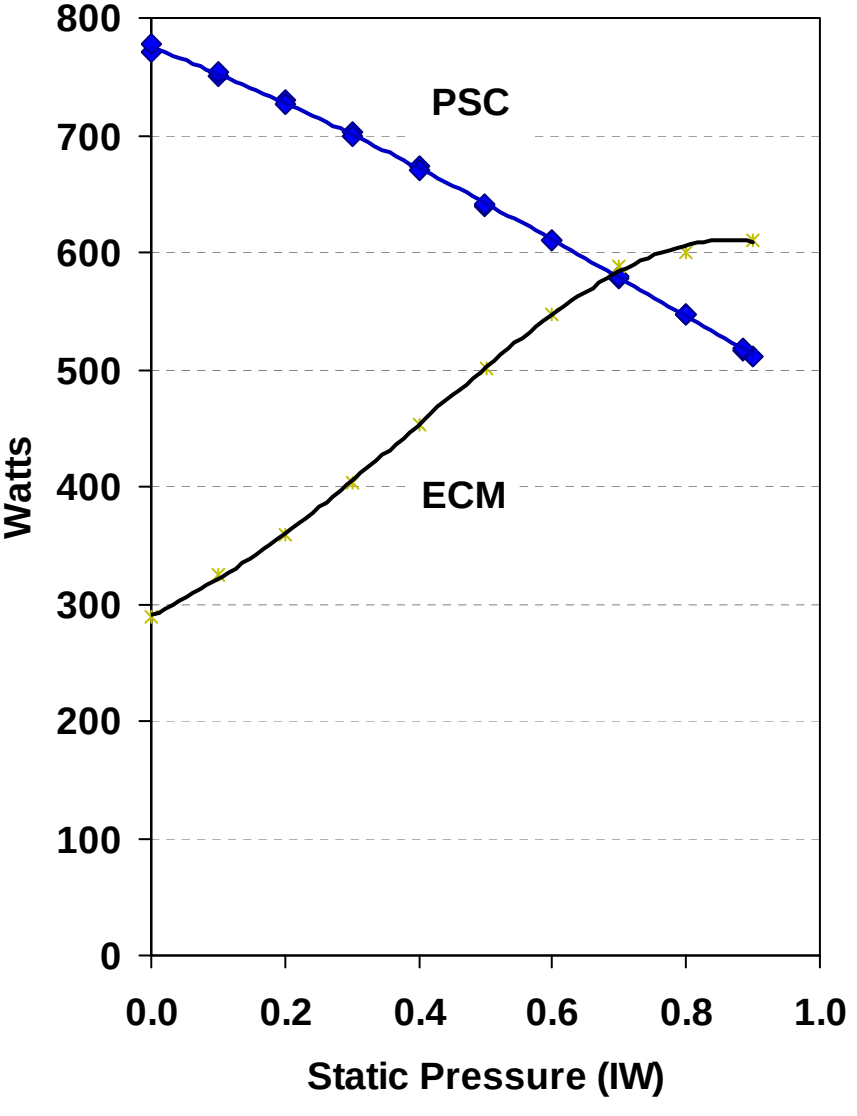
  Controls
  - Run the motor (electrical pulses)
  - Target airflow (ECM)
  - Duplicate existing airflow
  - Take advantage of other opportunities (performance and/or amenities)

Motor Comparison on Average Duct System



Motor Performance PSC vs. "Target CFM ECM"





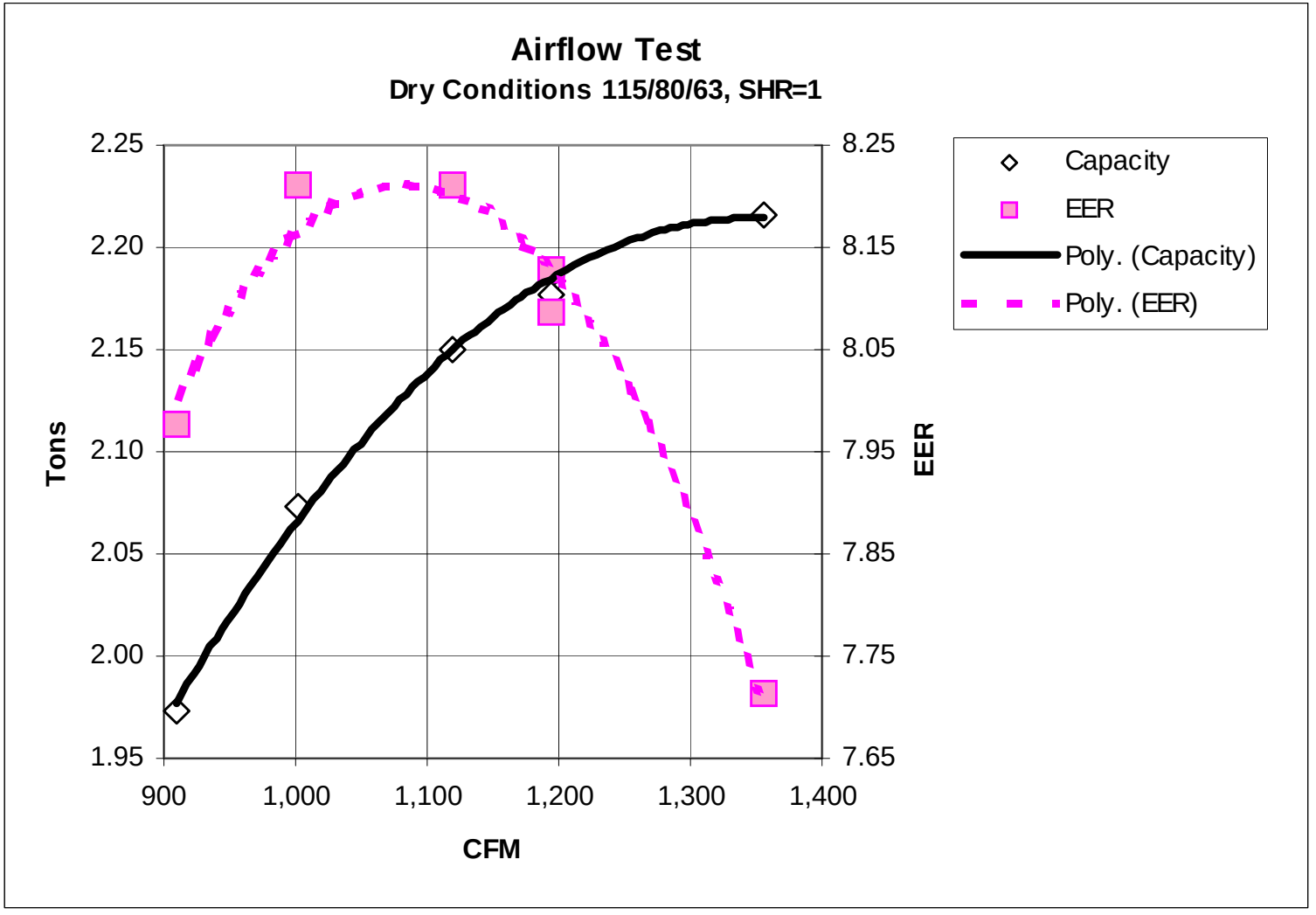
Guilty

- Some Airflow is Good
- How Much Airflow is Optimum?
- 350 CFM per ton?
- 400 CFM per ton?
- 450 CFM per ton?

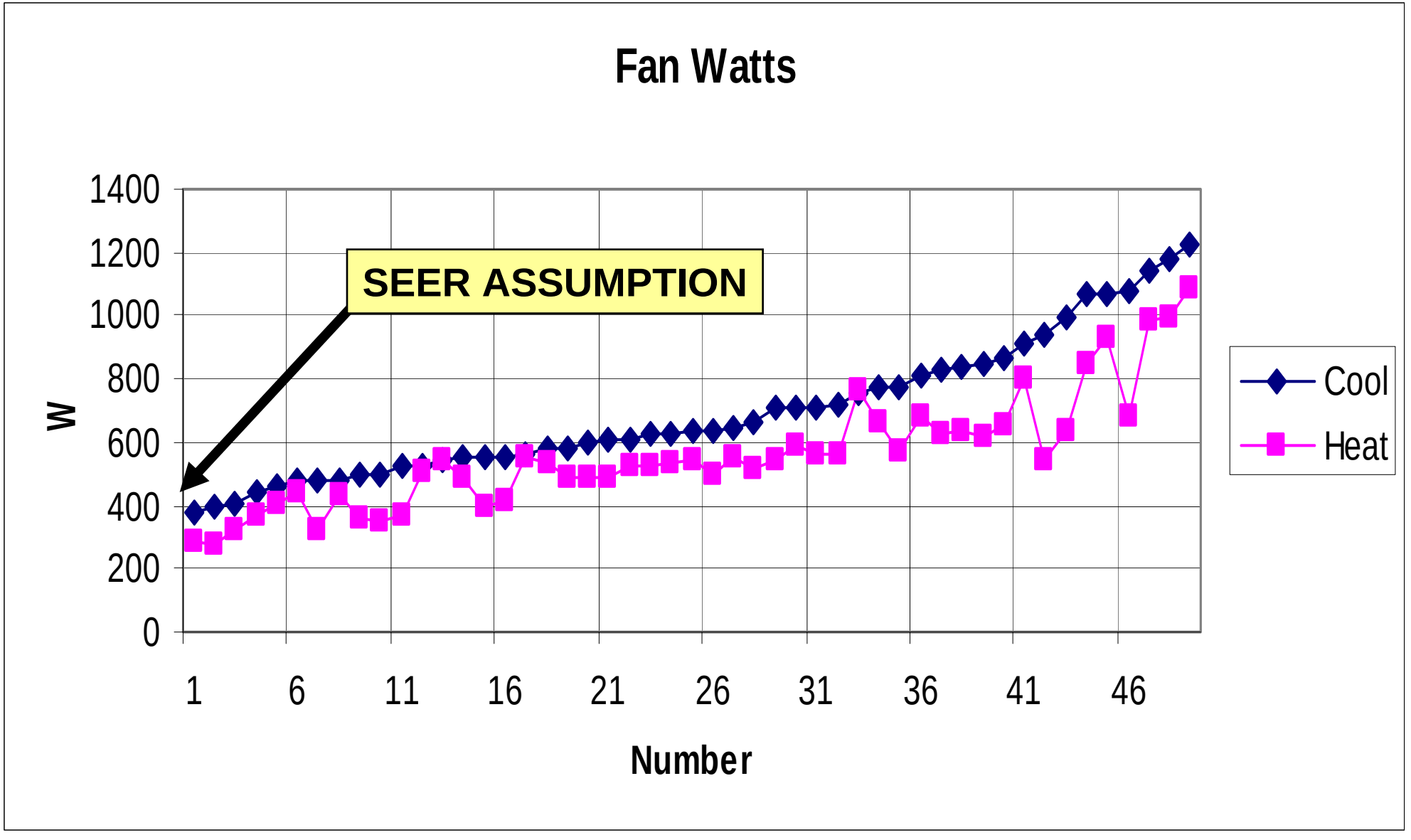
- Common Knowledge is Wrong
  Lots of Airflow is Not Good
  with current cabinet, heat exchanger, and duct designs

Lots of Airflow is NOT GOOD

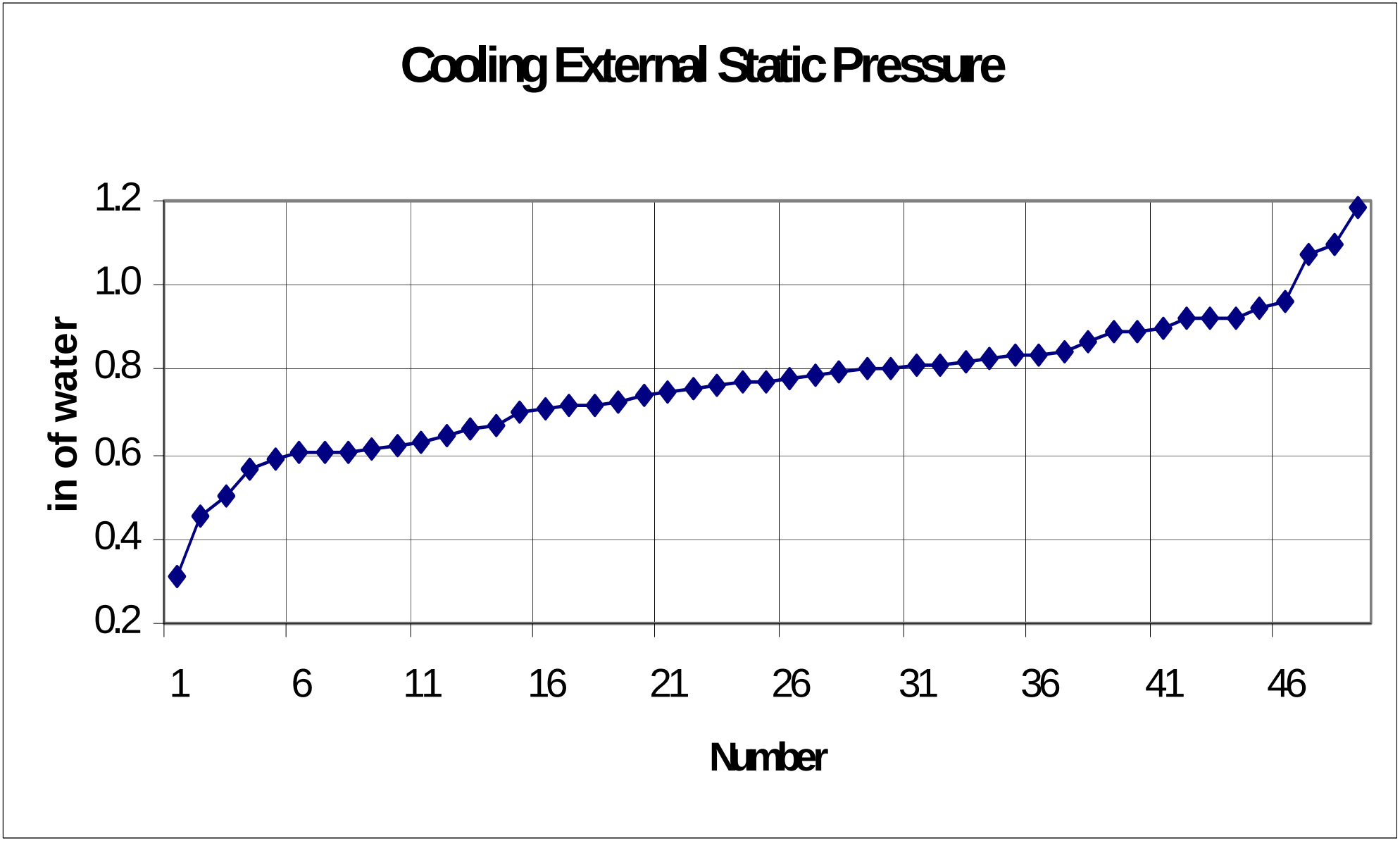
Diminishing Returns



Furnace Fan Watt Draw



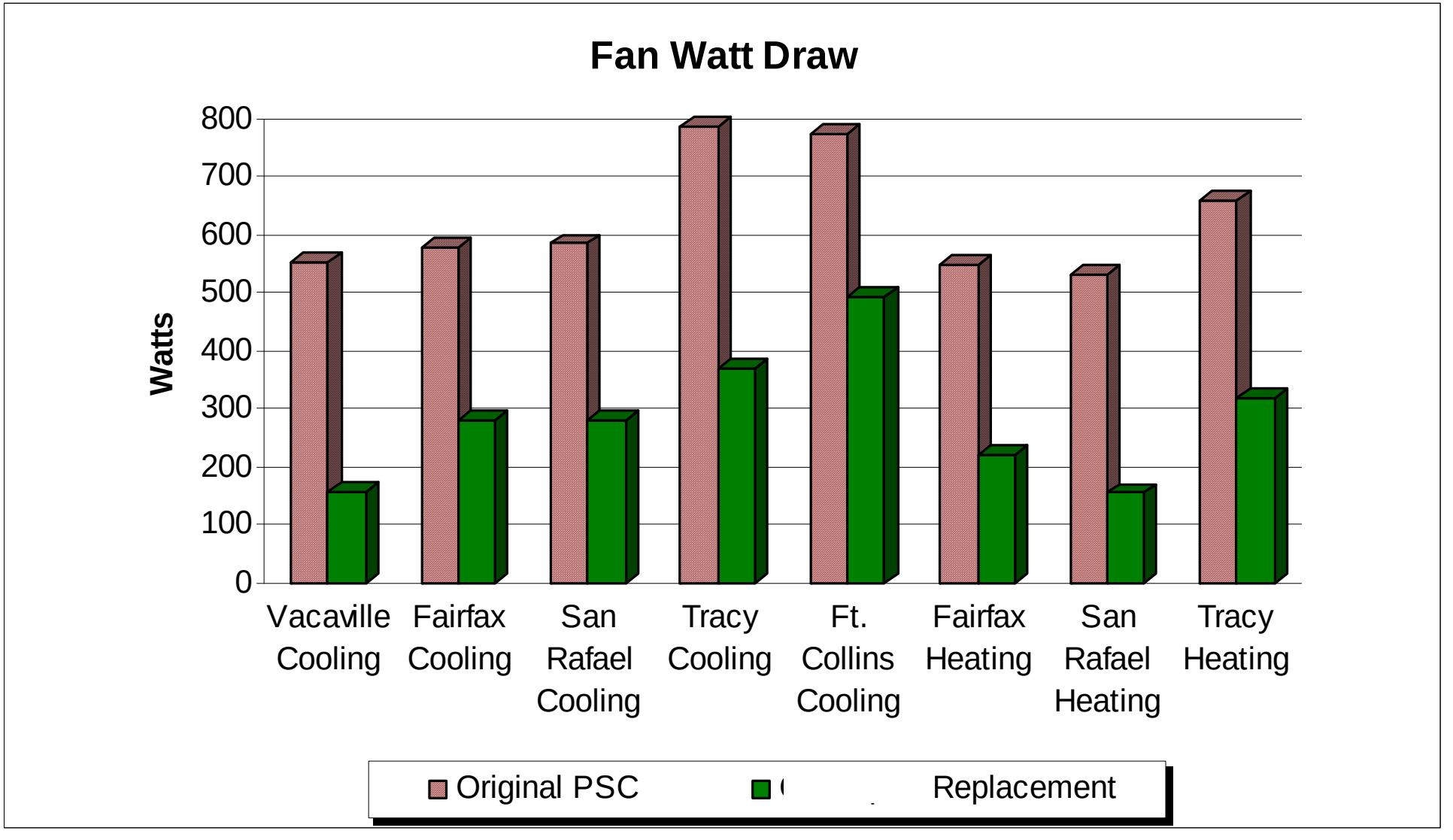
Air Flow Resistance



Concept 1 High Efficiency

- ~~Permanent Split Capacitor~~
  - ~~95+% of furnaces~~
- Brushless Permanent Magnet
  - ~~Target airflow (ECM)~~
  - Duplicate existing airflow

Case Studies



Heating Fan Energy

Heating Fan Energy Savings$_{eem}$ =
Baseline Furnace Gas Consumption X 0.50 kWh per Therm

For a unit with 194 Therms Furnace Gas Consumption

Heating Fan Energy Savings$_{eem}$ = ***97 kWh***

Gas Energy Increase$_{eem}$ =

$$\frac{\text{Heating Fan Energy Savings}_{eem} \text{ X 0.013414 Therms per kWh}}{\text{Furnace Efficiency}}$$

Gas Energy Increase$_{eem}$ = ***4 Therms***

Savings

- Heating Fan Energy 50%
- BPM Cooling 8% to 11%
  (duplicate CFM)
- Constant Circulation 90%
  (full turn-down)
  $ 370 at 11 cents per kWh

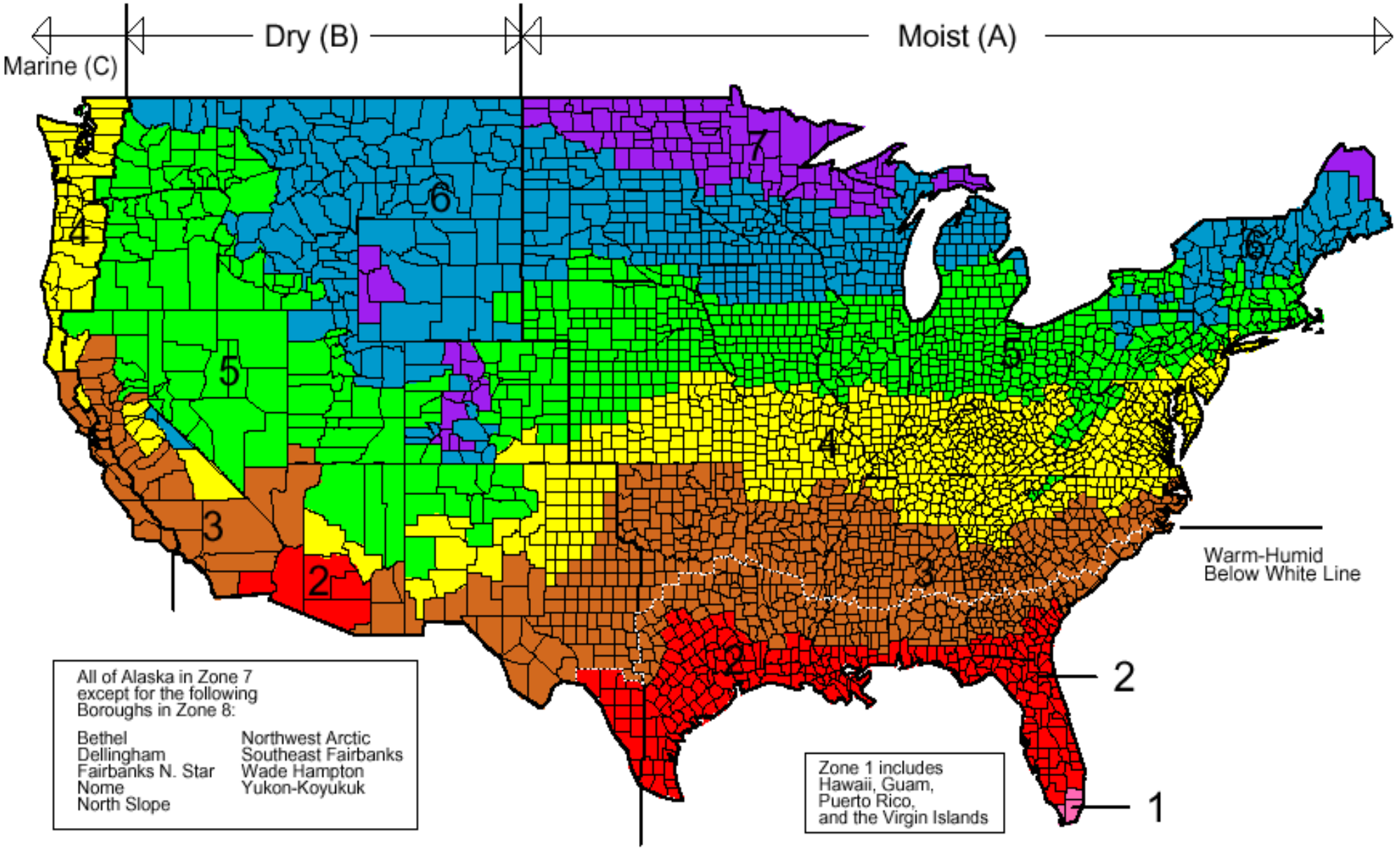
Control Opportunity
Concept 2 Climate Sensitivity

- High outdoor humidity
- Low outdoor humidity
- Low, Moderate, and High indoor humidity

There should be two regional AC standards with revised SEER test for the United States

1) Representative test static pressures and fan watt draws
2) Cycling at representative indoor conditions to show Latent vs. Sensible performance

United States Climates



An Air Conditioner

Reduces the Temperature –
Sensible Capacity

Removes Moisture –
Latent Capacity

Needs by Climates

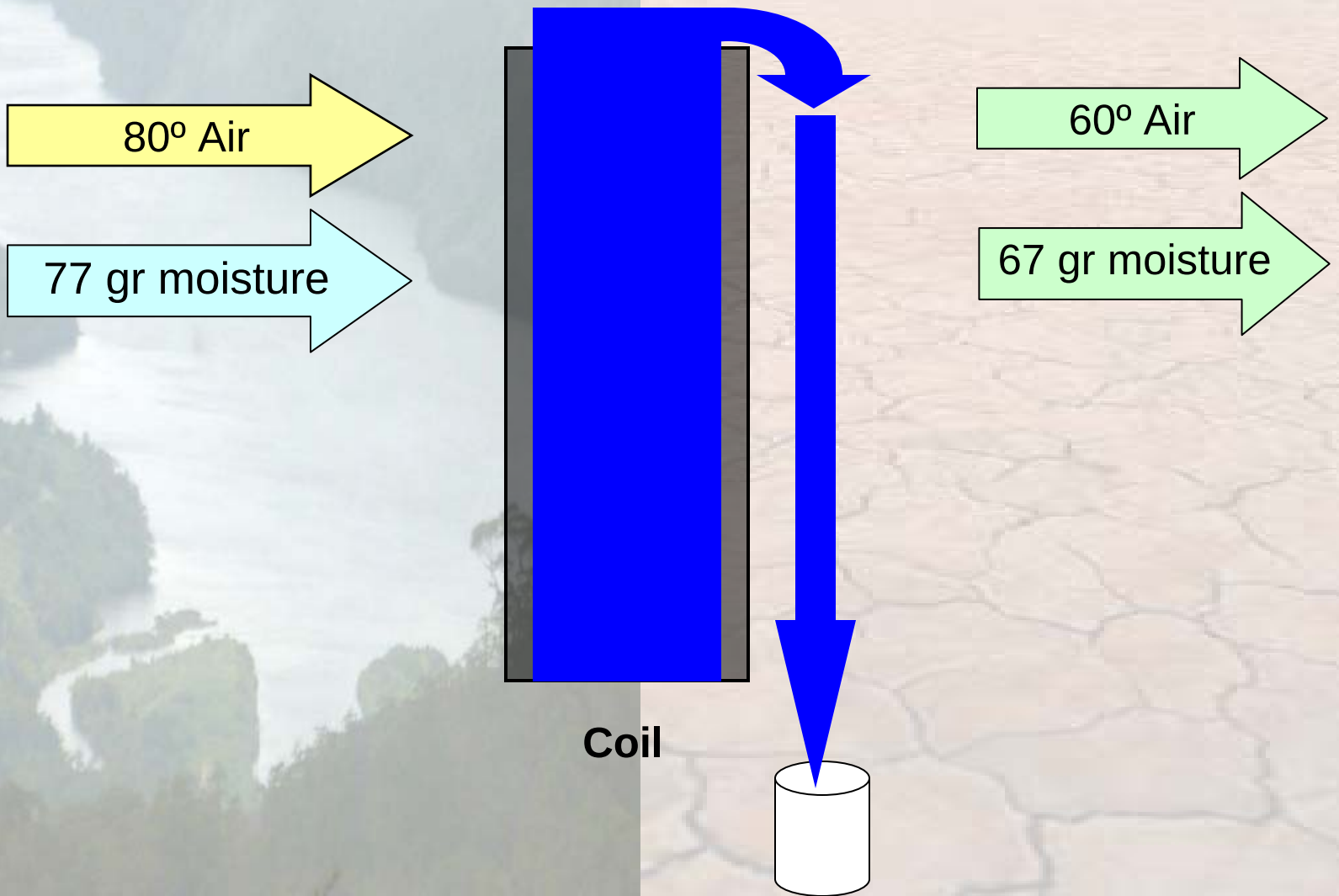
Typical Sensible Heat Ratios are 75% to 80%.

A. In Dry Climates we want to maximize sensible capacity
   - Sensible Heat Ratios approaching 1

B. In Wet Climates we want more latent cooling
   - Much Lower Sensible Heat Ratios

C. In Mixed Climates we want:
   - A sometimes (SHR $\rightarrow$ 1)
   - B other times (SHR < .75)

Latent Storage and Capacity



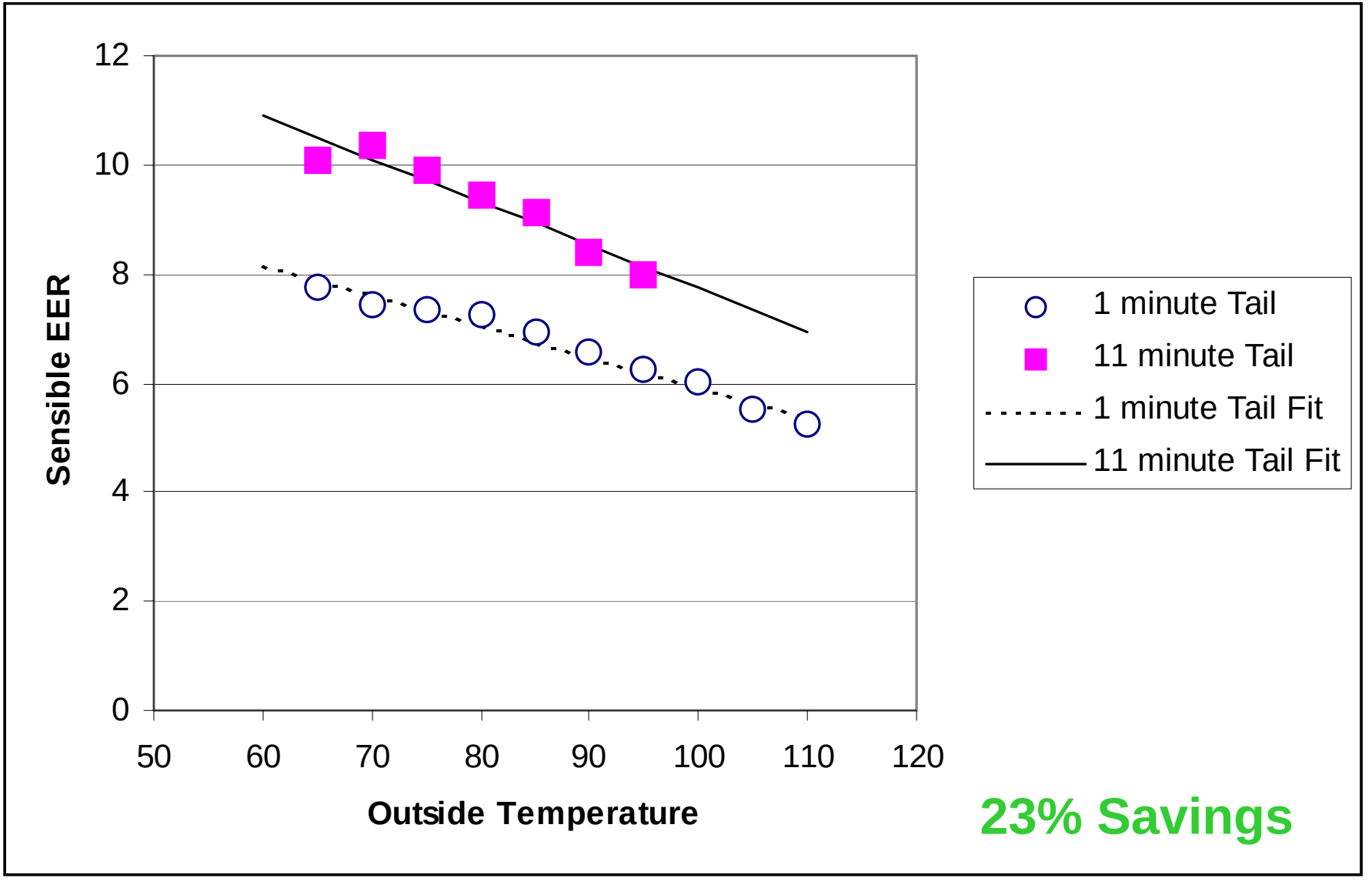
Moist Climate – Increase the Latent Capacity

- Run fan at lower speed to increase dehumidification
- Water is on the inside coil when the compressor shuts off
- Stop the fan motor and let it drain
- Units running constant fan shut off fan for 20 minutes or until next call for cooling.

Dry Climate – Convert Latent Capacity to Sensible Capacity

- **Water is on the inside coil when the compressor shuts off**
- **Evaporating the water off the coil converts latent to sensible capacity**
- **Run the fan after the compressor shuts off**

Converting Latent to Sensible Capacity



23% Savings

AC Field Test