

# HVAC Trends

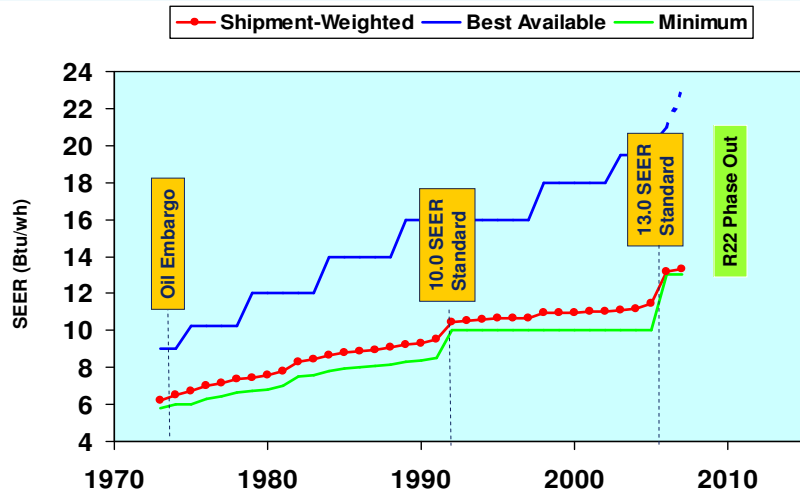
## A Compressor Manufacturer's Perspective

Hung M. Pham & John Schneider

CEE Industry Partners Meeting  
9/19/2006



## Residential SEER Trends



- Shipment-Weighted SEER Closer To Regulation Level
- Best Available Driven By Technology/Differentiation
- Industry Facing R22 Phase-Out In 2010



## Energy Policy Act 2010 Commercial A/C EER Standards

<u>Capacity</u>	<u>ASHRAE 90.1 EER</u>	<u>2010 EER</u>	<u>%Increase</u>
65 - 134K	10.3	11.2*	+9%
135 - 239K	9.7	11.0*	+13%
240 - 759K	9.5	10.0*	+5%

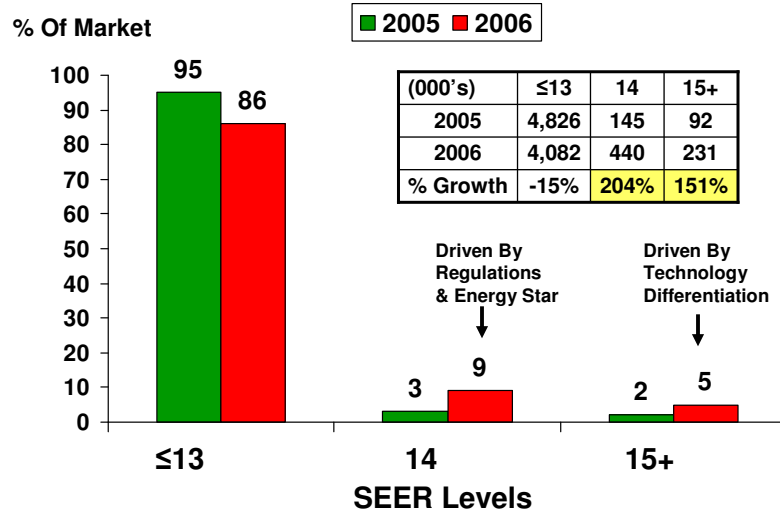
\* 0.2 Lower EER For A/C With Integrated Gas Heat  
H/P EER Requirements Are Also 0.2-0.5 Lower  
No IPLV Requirement

- Impact Yet To Be Seen
- States Will Be Pre-Empted After 2010 Std. Takes Effect

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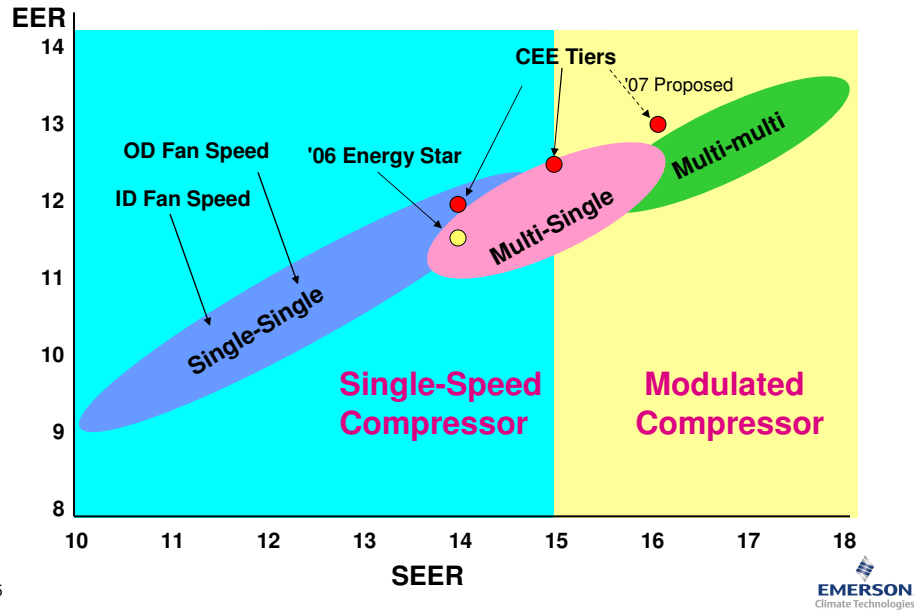
## Changing Market Dynamics Driving 14+ SEER Growth (ARI Data Jan-July '06)



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## New Challenge : Meeting EER And SEER



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## 13 SEER Impacts Unit Size/Cost



Longer Payback  
→  
30-40% Size Increase



**Suppliers**

**OEMs**

**Distributors**

**Homeowners**

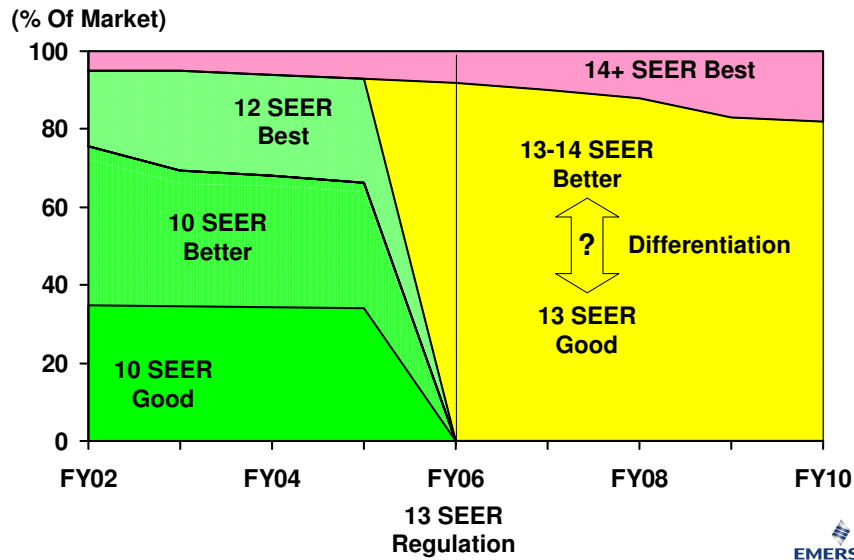
- 95% Of Unitary Will Be New Designs
- New Production Lines, Manufacturing Equipment
- Warehouse Expansions And Logistical Changes
- Inventory Planning
- Matched-System Replacement Cost

**Estimated Industry Investment \$1B**

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EMERSON  
Climate Technologies

## Regulations Drive Need For Differentiation And 14+SEER Growth



## New Differentiation Trends

### Differentiation Segments

- Unit Size Vs. SEER
- 15-16.0 SEER Advanced Tier
- Installation Verification  
Performance Monitoring

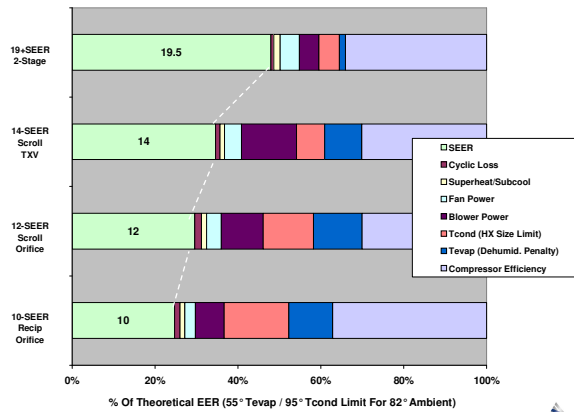
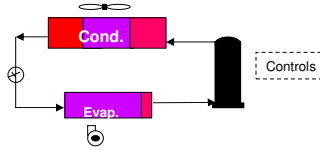
### Key Features

- Higher Compressor Efficiency  
Better Components
- Modulation, Comfort, Sound
- Embedded Electronics
  - Diagnostics
  - Data Communication

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## Typical Energy Loss/Improvement Areas

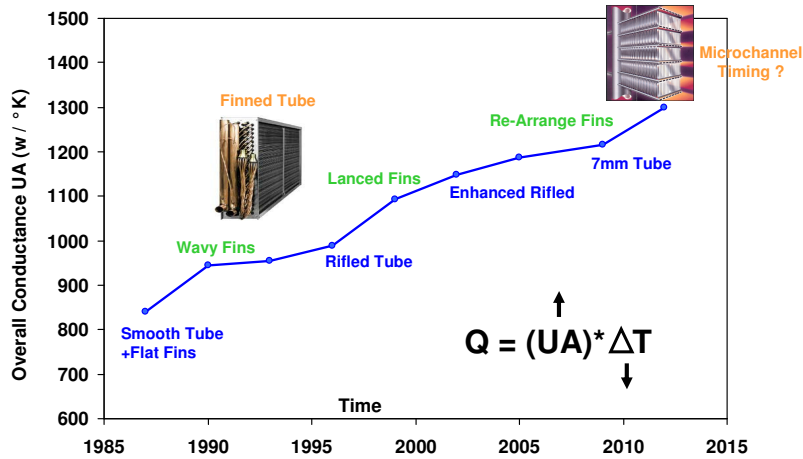
- **Improve Component Efficiencies**
  - Compressor Efficiency
  - Better Fan cfm/w
  - New Heat Exchanger
  - Improve Flow Control
- **Reduce Temperature Lift**
  - Lower Tcond
  - Higher Tevap
  - Minimize Superheat
  - Efficient Subcooling
- **Reduce Transient Losses**
  - Cyclic
  - Frost/Defrost
- **Systems Integration**
  - Modulated Compressor
  - Variable-Speed Fans
  - Zoning



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## Heat Exchanger Trends Reaching Diminishing Return → Oversizing

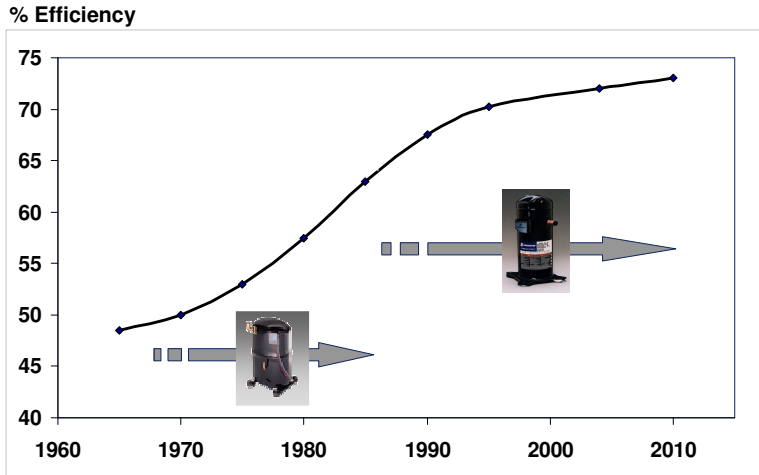


**Need Advances To Continue To Contribute To Reducing  $\Delta T$**   
 • Driven By Size, Commodity Cost, R410A Refrigerant Cost  
 • 7mm Tube And Microchannel

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## Compressor Efficiency Trends Fixed-Speed Reaching Top Arena



Scroll Technology Has Contributed Continued Increasing Efficiency Trend

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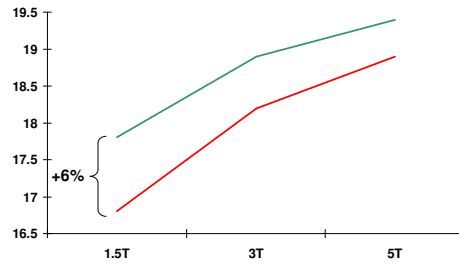


## Residential Next Generation Fixed-Speed Scroll



Technology Enables  
Frame Size Reduction

CHEER (45/100 °F)



- Higher Efficiency (+2-6%)
- Quieter Operation (66-68 dBA)
- Improved Reliability/Quality
- Smaller Frame Size
- Broadly Applied By Most OEMs

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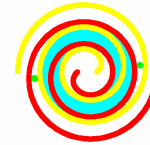
## Two-Step Scroll Best Segment

➔ Trophy Efficiency (Up To 21.0 SEER)

- Better Comfort (67% Part Load Capacity)
- Quieter Operation (Sound And Vibration)
- Simpler Design
  - Inherent Scroll Design
  - No Shutdown To Change Capacity
  - Less Applied Components
- Proven Scroll Reliability
- Product Launched January 2003
  - Split & Package Applications
  - 16-21 SEER
  - >230K Sold To-Date



100% Capacity  
(Ports Open)



67% Capacity  
(Ports Closed)

## Air Flow And Refrigerant Flow Modulation

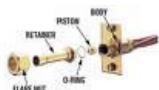


Standard PSC Fan Motor



Inverter-DC Fan Motor

Typical SEER Gains  
1+ SEER (Fixed-Speed A/C)  
2+ SEER (Modulated A/C)



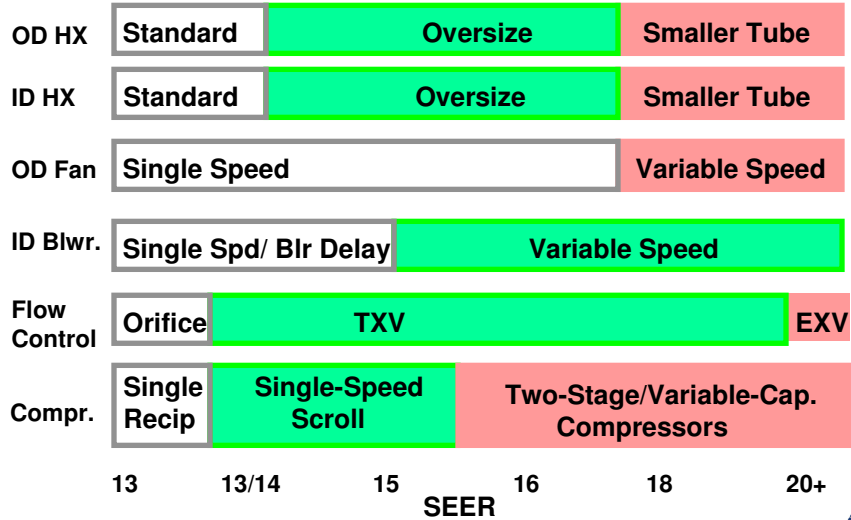
Fixed Flow Orifice



Thermostatic Expansion Valve  
- Better Superheat Control  
- Less Cyclic Loss } 0.25 SEER

TXVs In U.S. Residential  
Shift Overnight From ~20% to ~85%

## Typical Integration Trends

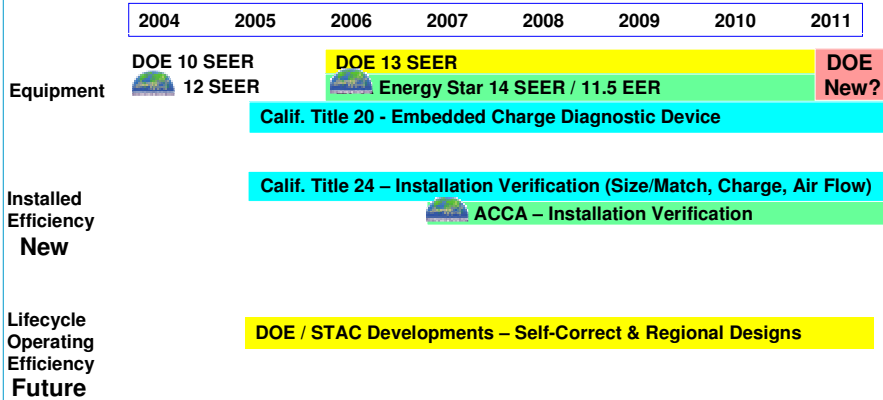


Controls Will Play Key Role In Integrating Components



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## New Regulations - Installation Verification



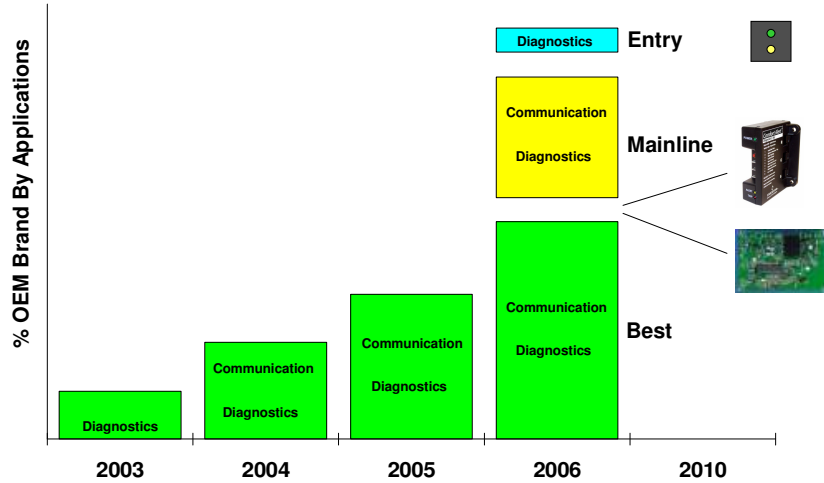
- Driven By Diminishing Return Of Higher SEERs
- Focus On Installed And In-Field Operating Efficiency
- Will Drive Increased Interest In "Self-Correcting" Components (TXV) And Embedded Diagnostics That Can Provide Cost-Effective Verification



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## OEM Adoption Of Embedded Electronics\*

\* Outdoor Electronics Beyond Defrost Control



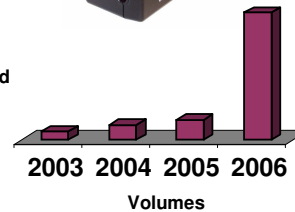
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## Comfort Alert Diagnostics Gained Market Acceptance



- Simple, Innovative Technology Using Compressor As A Sensor For System Faults
- Embedded In Outdoor Unit Electrical Box
- Diagnoses Electrical And Systems-Related Faults
- Improves Diagnostic Accuracy By 60%
- Proven To Lower "No Defect Found" Field Failure Rates And Reduce Callbacks By 50%.
- Large Ramp Up In 2006 As Acceptance Increased
- Most OEMs Applied 1-Phase Version In Residential
- Few OEMs Applying 3-Phase Version In Commercial

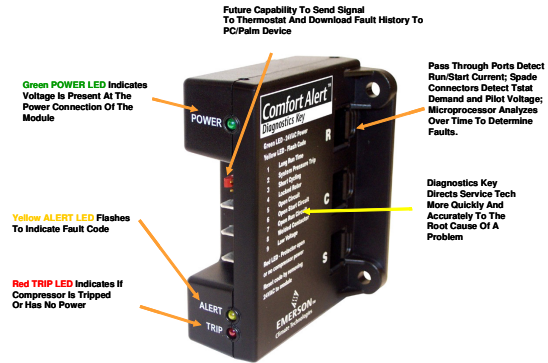


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## System And Electrical Alert Codes

- Long Run Time (Code 1)
- System Pressure Trip (Code 2)
- Short Cycling (Code 3)
- Locked Rotor (Code 4)
- Open Circuit (Code 5)
- Open Start Circuit (Code 6)\*
- Open Run Circuit (Code 7)\*\*
- Welded Contactor (Code 8)
- Low Voltage (Code 9)



Commercial 3-Phase Version  
 \* Missing Phase  
 \*\*Reverse Phase

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## Comfort Alert™ Product Line Evolution



1st Generation

2nd Generation  
Fixed Capacity

2nd Generation  
Two-Stage

2nd Generation  
Commercial

L Terminal

L Terminal  
2 Stage Control  
Reduced VA  
Part Load Start

L Terminal  
2 Stage Control  
Reduced VA  
Part Load Start  
3 Phase Miswire  
Active Protection

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## Communication Enables Smarter Diagnostic And Protection

### Comfort Alert

- Monitors Compressor
- Communicates To User Interface

### User Interface

- Controls Temp/Humidity
- Protects The Compressor



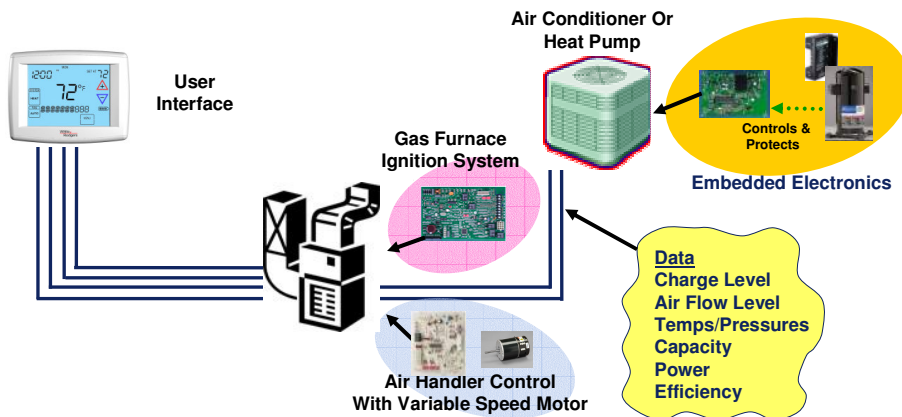
### Two-Stage Scroll

- More Efficient
- Superior Comfort
- Enhanced Reliability

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## Residential Communicating System Best Segment



- Communication Will Continue To Evolve
- Enriched With System Data Content For Assisting Contractors
- Enable Verification Services And Performance Monitoring

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## ***Summary***

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- **HVAC Industry Entering New Period Of Efficiency And Refrigerant Regulations In Both Residential And Commercial**
  - SEER
  - EER
  - Refrigerant Phase-Out
  - Installation Verification
- **Challenge Is Differentiation And Meeting Regulations Cost-Effectively**
  - Cost Pressure Paced By Residential
- **Natural Gas Cost Driving Renewed Heat Pump Growth**
- **Embedded Controls Will Play Important Role In Future**
  - Component Integration
  - Diagnostic, Protection, Communication, Installation Services