

Western Cooling Challenge

Mark Modera

Director, Western Cooling Efficiency Center

University of California, Davis



CEE Presentation: January 15, 2009

University of California, Davis
WCEC
WESTERN COOLING
EFFICIENCY CENTER

RESEARCH • INNOVATION • PARTNERSHIP

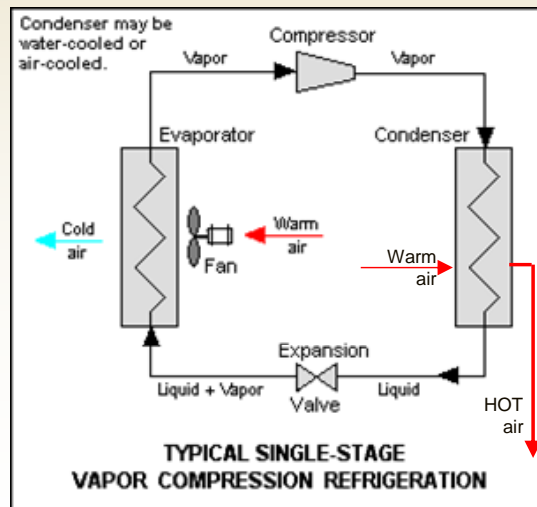
Western Cooling = Main Culprit in Utility Peaks

- July peak demand is 35% above January
- Cooling causes electricity peaks
 - 7% Load Factor for Residential
 - **22%** Load Factor for Non-Residential
- Cooling peak reducers - best new peaking plants



Western Climates: Issues = Opportunities

- Large Diurnal Temperature Swings
 - Issue – Poor Load Factor
 - Opportunity – Thermal Storage
- Low Outdoor Humidity
 - Issue – Non-Optimized Equipment
 - Opportunity – Evaporation for Cooling, Radiant Cooling



WCEC: Who We Are

- Part of the Energy Efficiency Center at University of California, Davis
- Launched April 2007
- Current staff:
 - Mark Modera, Director
 - Dick Bourne, Associate Director
 - Marshall Hunt, Programs Director
 - Kristin Heinemeier, Senior Engineer
 - Seven Mechanical Engineering Students



WCEC: Who We Are

- Affiliate Structure
 - Utilities
 - PG&E, SCE, SMUD, SEMPRA
 - Manufacturers
 - Carrier, Coolerado, Ice Energy, ICI, Lennox, Munters, NovaTorque, Seeley Intl., Speakman, Trane, Uponor, Viega, VRTX
 - Contracting/Design Firms
 - Beutler, Davis Energy Group, Timmons Design Engineers
 - State Agencies
 - CEC, DGS
 - Retailers
 - Wal-Mart, Target

What We Do

- Cooling technologies optimized for hot, dry west
 - New Construction and Retrofit
 - Help bridge commercialization “valley of death”
 - Affiliate alliances/partnerships
 - Demonstrations
 - Codes and standards
- Research and development
 - Technology development
 - Laboratory and field testing
 - Modeling and analysis
- Outreach activities
 - Catalog of energy-efficient cooling systems
 - Website, newsletters, presentations, publications
 - Education

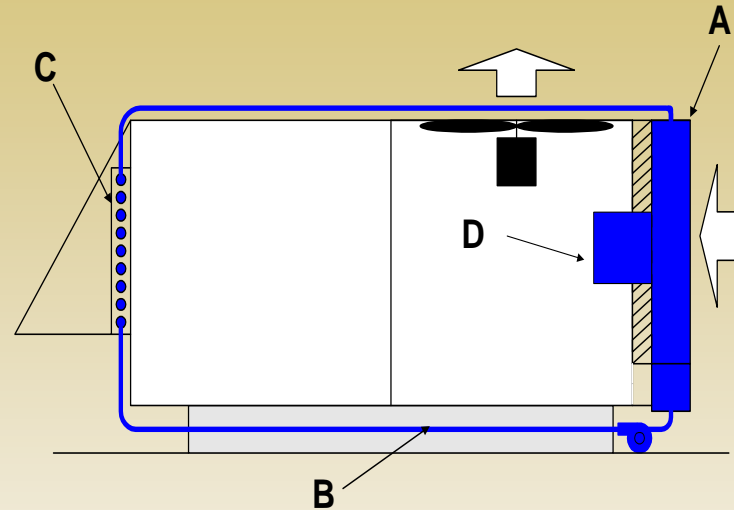


WCEC Technology Portfolio

- Most technologies appropriate for new and retrofit
 - Roof-top packaged units (including night-time ice)
 - Evaporative cooling technologies
 - Hybrid evaporative/vapor-compression equipment
 - Water-cooled condensers
 - Swimming-pool-based air conditioners
 - Thermal distribution systems
- Some opportunities unique to new construction:
 - Low-cost chilled water storage
 - Radiant floors
 - Night-sky radiative cooling

Example Technology: DualCool

- Accessory system for RTUs
- Pre-cools condenser and ventilation air
- DOES NOT add moisture to indoors
- 25-30% energy and demand savings



SYSTEM SCHEMATIC

- A - High quality condenser air pre-cooler
- B - Pump & copper supply/return piping
- C - Ventilation air precooling coil
- D - Controls

Example Technology: Roll-Out Radiant Floor

- Prior cost \$6-7/ft²
- Rollout cost ~\$2/ft²
- Full-scale installation at Wal-Mart store

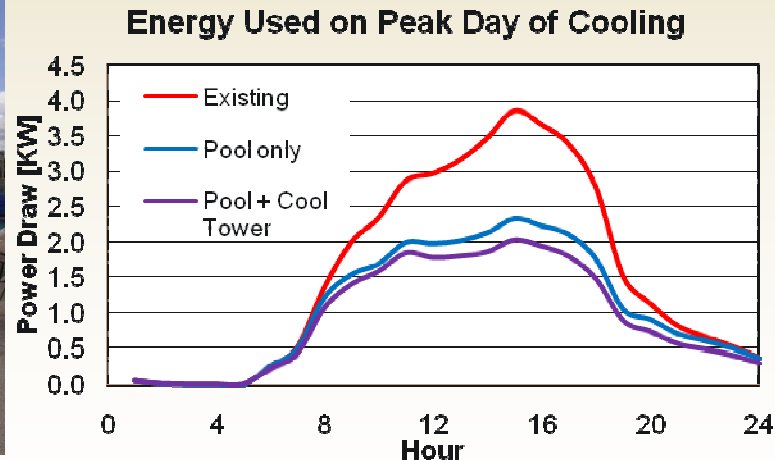


- Reduces latent cooling and blower energy
- Facilitates non-compressor cooling

Example Technology: Integrated System

• Residential/Commercial Swimming Pools

- Night-time cooling (non-refrigerative) makes pool water available for day-time low-temperature heat rejection
 - 20-40°F reduction in refrigerant condensing temperature
 - 20-50% improvement in EER – higher at peak conditions
- Rejected heat serves useful function
 - Eliminates/reduces gas consumption for pool heating



Western Cooling Challenge

- **Target Market:** Roof-Top Units (RTUs) with 3 – 30 ton capacity (>500-unit production capacity)
RTUs cool 70% of non-residential floor space in the Western US
- **Target Performance:** 40% reduction in energy use and peak electricity demand
- **Reward Structure:** MOUs w CA IOUs and SMUD for incentive programs – Retailer program sponsorship

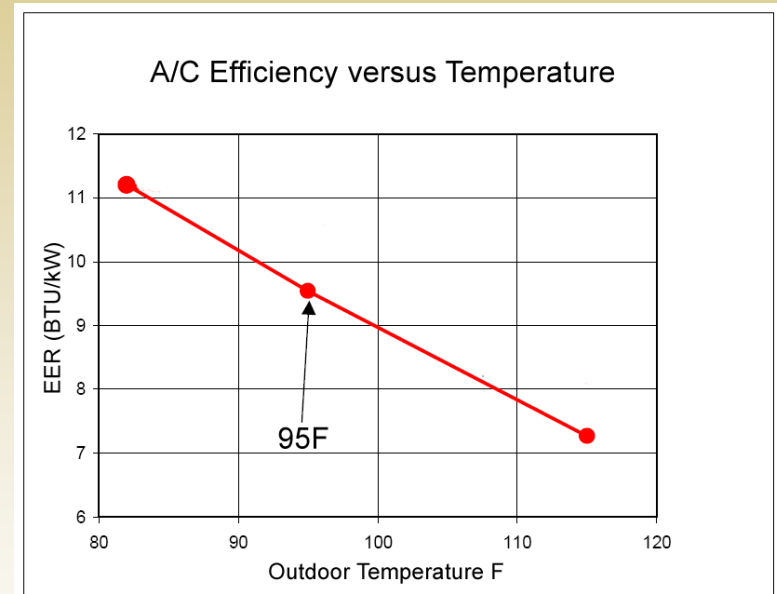


Western Cooling Challenge: Performance

- Sensible **EER** (w/all parasitics):
 - at 105db/73wb: **14.0**
 - at 90db/64wb: **17.0**
- Max **gal/ton-hr** at 90/64: **4**
(with 200 ppm hardness mineral content)
- Testing/data-analysis under WCEC observation
(at manufacturer's location or third-party facility)
- External static at 350 cfm/ton **0.7" H₂O**
- MERV 7 Filtration
- Outdoor Air **120 cfm/ton**
- Max Supply Humidity Ratio: **0.0092**
- No use of R-22
- Integral FDD, Voltage droop response

R-410A and Condenser-Air Pre-Cooling

- Analysis Technique
 - Calculate change in EER with respect to condenser air temperature
 - Relatively linear
 - ~1% change per °F for R-22
 - ~2% change per °F for R-410A
 - Calculate condenser temperature change per unit of water evaporated
 - Use EER change to calculate extra cooling delivered for the same electricity consumed



$$\eta_{cc} = 15 - 30\%$$

Western Cooling Challenge: Key Issues

- **Performance Targets:**
 - Ground-up re-design eliminates major manufacturers
 - Based upon combinations of bolt-on components and existing high-efficiency equipment
- **Technology Options:**
 - Working with all entrants to help them produce viable entries
 - Ground-up, high-performance hybrid, evaporative systems (100% OA)
 - Indirect evaporative, direct evaporative, DX, high-efficiency motors and fans
 - Accessorized existing equipment
 - Evaporative condenser pre-coolers
 - Indirect evaporative outdoor-air pre-cooling
 - High-efficiency variable-speed motors

Western Cooling Challenge: Key Issues

- **Performance Metrics:**

- Currently Western peak and seasonal steady-state test points
- Limit technologies to be considered
 - Thermal storage, intelligent controls, capacity modulation, component modulation **OFF THE TABLE**
- Need 24-hour test, variable indoor loads, realistic outdoor condition profile

- **Performance Simulation:**

- Hour by hour performance – particularly important in CA
- New technology combinations must be handled
 - Indirect, direct, DX, variable-speed motors, controls
 - FDD, Voltage droop performance
- Coordination with improved test protocols

Western Cooling Challenge: Entry Status

Company	Original Equipment Manufacturer	Component Supplier
AMAX	Air handling equipment with evaporation and refrigeration	
Coolerado	Hybrid cooling units with indirect evaporative cooling	Advanced indirect evaporative module
Desert Aire	Dehumidification and dedicated outdoor air equipment	
Ice-Energy	Modular ice storage equipment and controls technologies	
Integrated Comfort Inc		Evaporative condenser pre-cooler, indirect outdoor air cooling
Munters	Full line of roof top humidity control equipment combining evaporative and refrigeration components	
Munters-Des Champs, DEG	Roof top humidity control equipment (partnership with Davis Energy Group)	
NovaTorque		Super-efficient, variable speed motors
Seeley International	Direct and indirect evaporative cooling equipment	Advanced indirect evaporative module
Thermal-Flow		Fluid coolers for RTUs
Trane	Full line of roof top unitary equipment (RTUs)	
United Metal Products	Full line of evaporative equipment (RTUs)	

Western Cooling Challenge: Schedule

- January 2009 Laboratory testing of WCC entries can begin
- June 2009 Field testing of WCC entries can begin
- January 2010 Shipments of WCC-compliant products can begin



Western Cooling Challenge: Current Activities

- Assisting manufacturers
- Scheduling testing of equipment (USD OE)
- Producing annual and peak savings estimates
- Working with CA utilities on incentive programs
- Looking for non-California utility participants
- Developing metrics for “OFF-THE-TABLE” technologies – nation-wide applications (USD OE)

Marshall Hunt (mbhunt@ucdavis.edu)

<http://wcec.ucdavis.edu/>