**22 sept. 2017**
**Marseille**

APPRENDRE
ET ÉCHANGER SUR
LES STRATÉGIES CONCRÈTES
LIÉES AU CONFORT
D'ÉTÉ !

# 2017 BÂTI' Marseille FRAIS

## 3ÈME COLLOQUE CONFORT D'ÉTÉ

# L'INVITE 2017

# Le confort d'été en milieu aride Californien

**Dick BOURNE**

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# 21st Century Cooling for Dry Climates: A California Summary for Bati'Frais

**Dick Bourne, President**
**Integrated Comfort, Inc.**
**September 22, 2017**

# Presentation Overview

- Climate and Comfort
- Buildings
- Cooling Systems
- Electricity
- Solutions
  - Passive Design
  - Evaporative Cooling
  - Integrated Design
- The WCEC
- Conclusions

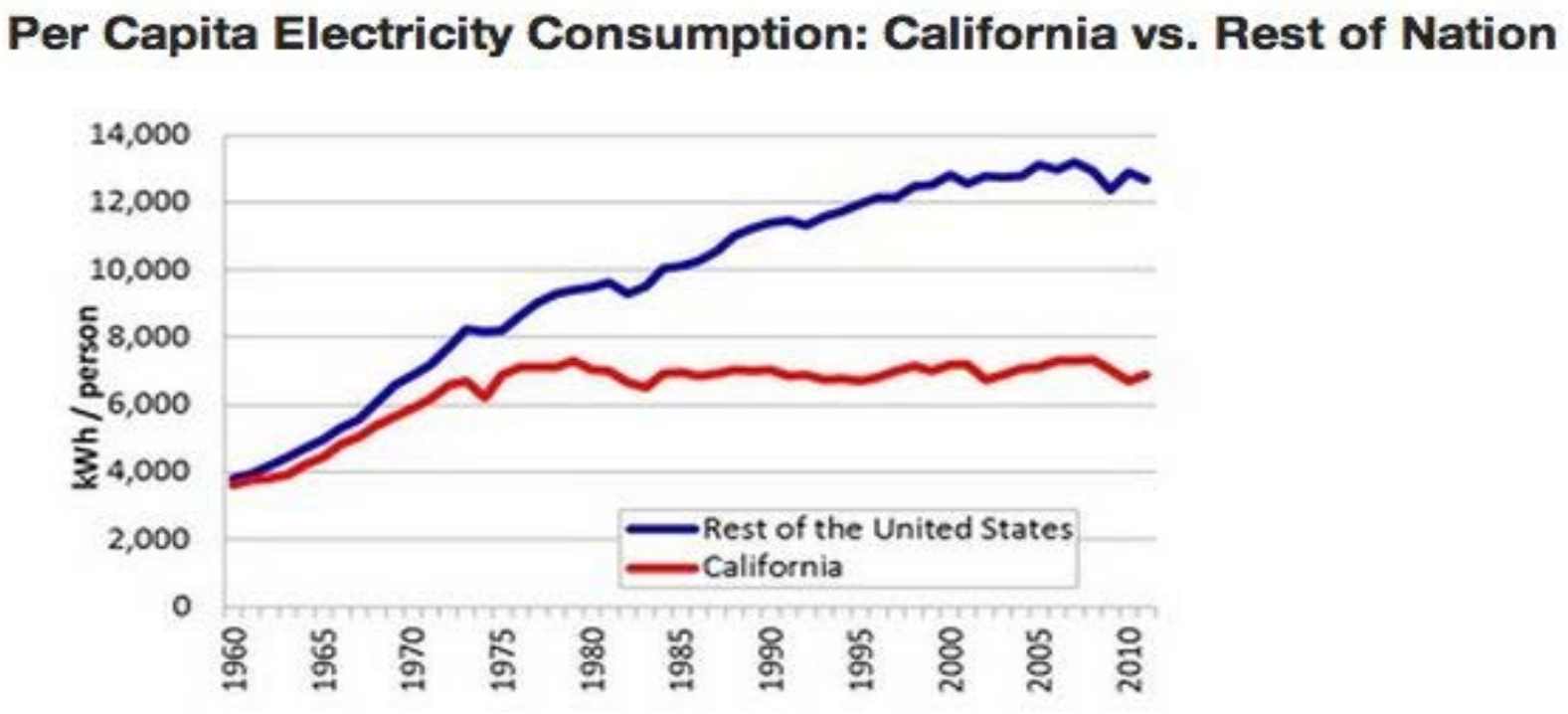
# Climate

- 16 CEC climate zones
- Dry, except North Coast
- Mild coastal cities
- Hot dry central valley
- Clear summer nights
- Valley summers:
  - Highs 35-45C
  - Lows  13-20C
  - Peak hour RH 15-35%

# California Success Story

Pourquoi?

- Energy efficiency mandates
- Title-24 Building Standards
- Appliance standards



# The Dry Western US

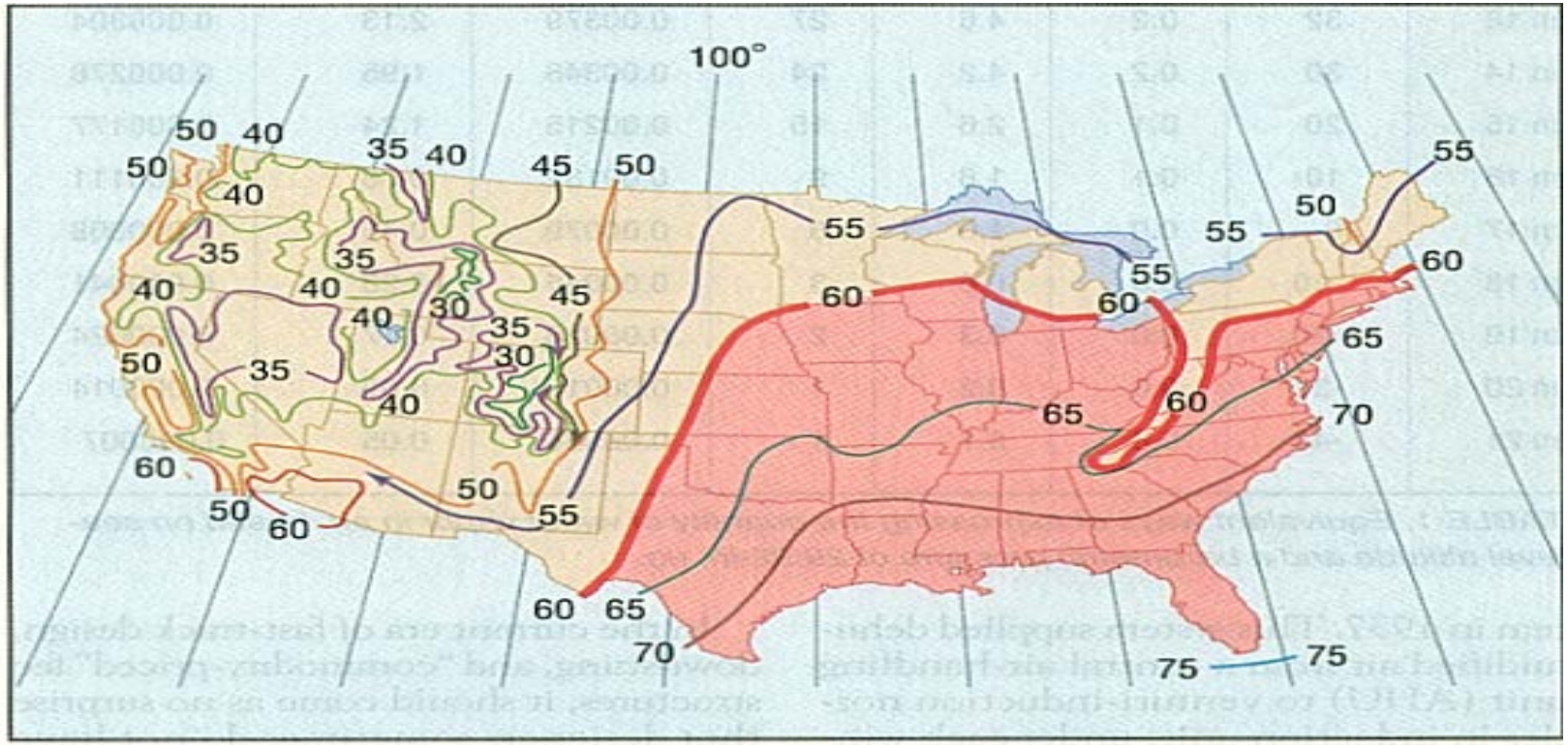


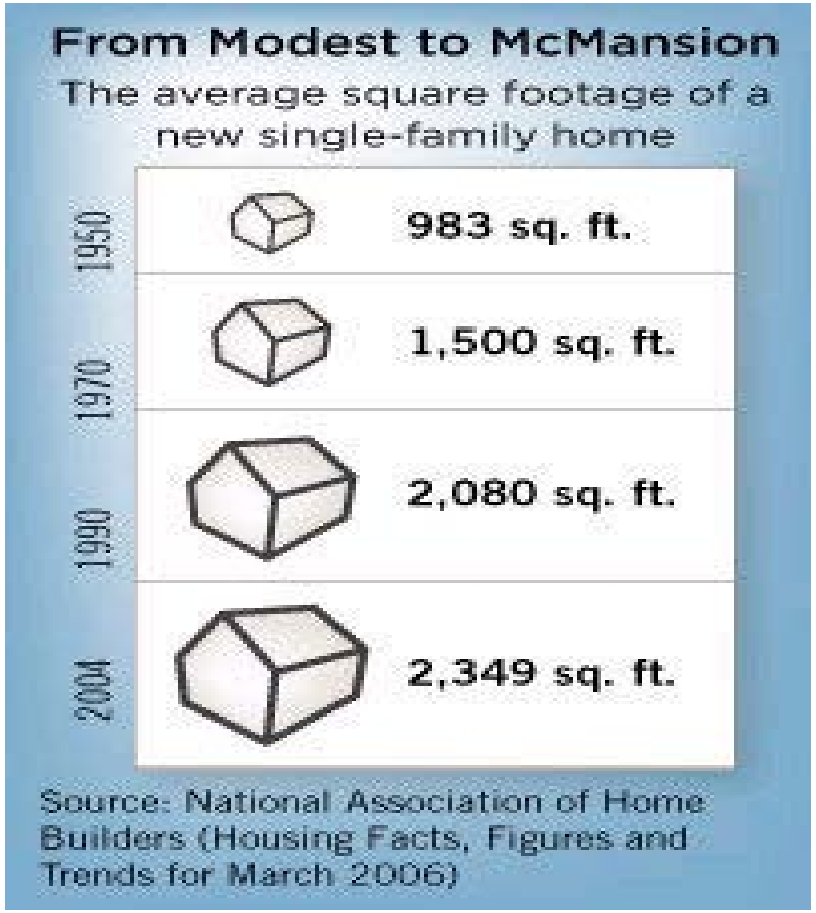

*FIGURE 1. Mean dew-point temperature isolines for August (1946 to 1965).*
*Source:* Climatic Atlas of the United States.

# California Summer Comfort

- Expectations
  - Homes: 24 – 26C
  - Commercial: 22-24C
- Operation
  - Mostly automatic
  - Windows closed
- Ventilation
  - Homes- minimal
  - Commercial- significant
- Ceiling fans common

# Typical Residential

- All wood-framed, tract-built
- Foundation & Siding
  - Pre-1960: raised floor, wood exterior
  - 1960-1990: slab floor, wood exterior
  - Since 1990: 2 story, slab, stucco
  - Apartments 2 or 3 story
- Trends
  - Size: bigger, on smaller lots
  - Bigger, better windows
  - Title-24 energy features
  - Photovoltaic



Bird’s-eye view of recent Southern California  tract housing in the desert

# Typical Retail

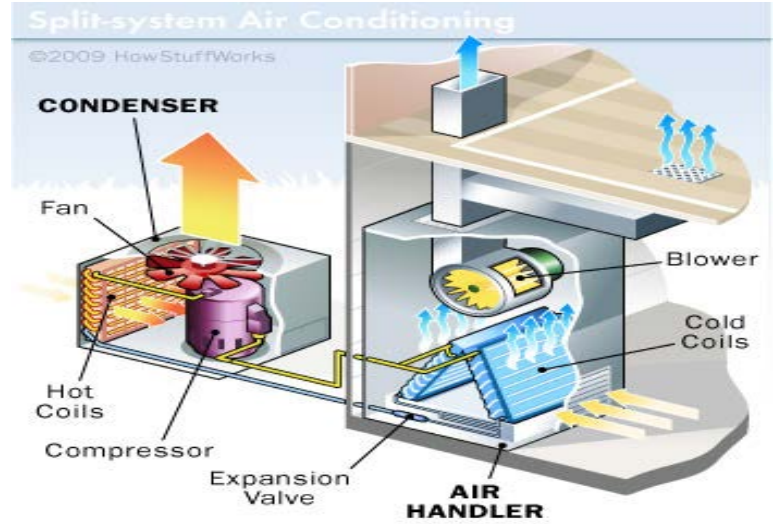
- Mostly one-story
- Usually in “shopping centers”
- Long operating hours, some 24/7
- HVAC uses rooftop units (“RTUs”)
- Typically cooling-dominated
- Fresh air supplied by RTUs

# Typical Office

- Mostly multi-story
- Usually in “office parks”
- Weekdays only
- Low-rise use RTUs
- “High-end” may use chiller (“built-up”)
- Typically cooling-dominated
- Fresh air required

# Conventional Cooling

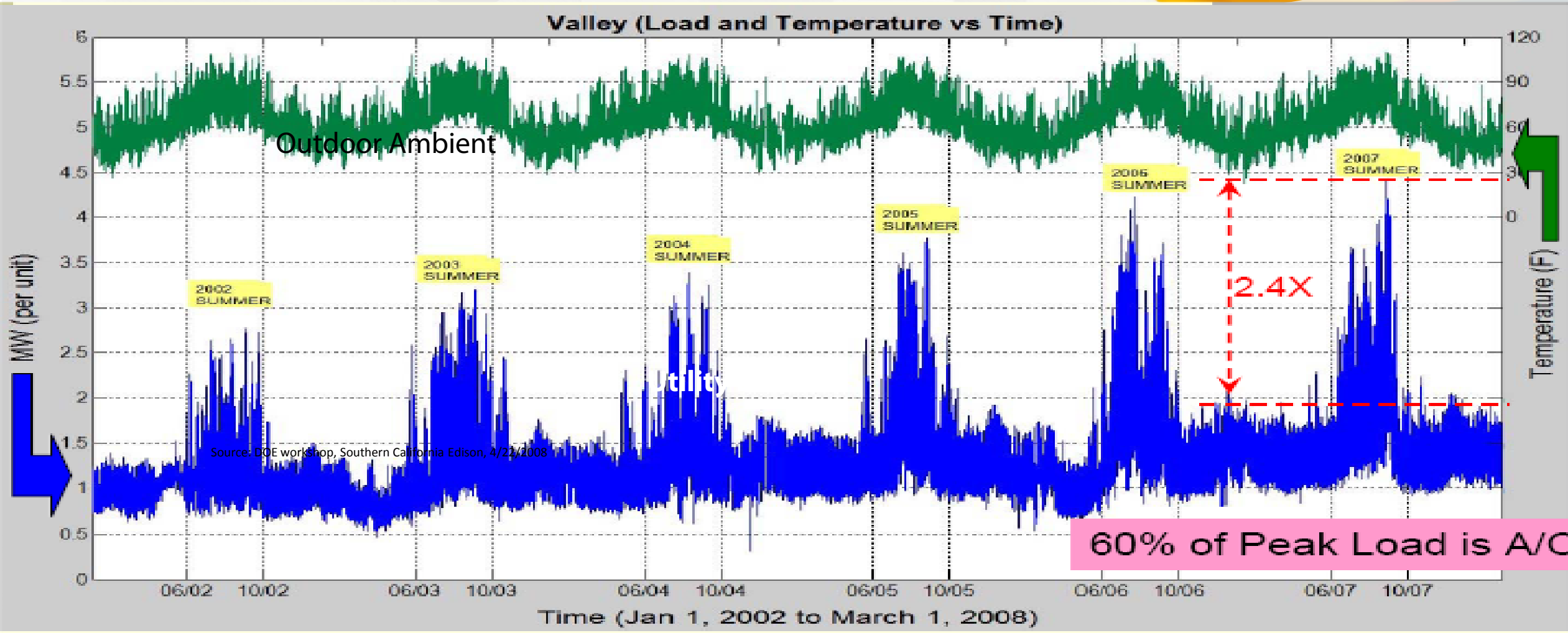
- Air-cooled, compressor-based
- Mostly “split system” residential
  - Keeps equipment off roof
  - Maximum design flexibility
- Mostly “packaged” commercial
  - Rooftop space available
  - Allows central blower location
  - Incorporates fresh air supply
  - Economizers on larger units
- Less common
  - Central hydronic
  - Ground-coupled




# The Electricity Scene

- CA $/kWh high vs. US, similar to France
- Cooling “spikes” cause major peak loads
- Not much coal or nuclear, lots of gas
- 25% wind and solar in 2016
- Concern about renewables exceeding demand
- Major opportunity for improving cooling systems to reduce peak demand and balance electric loads

# Six Year CA. Valley Peak Load Data

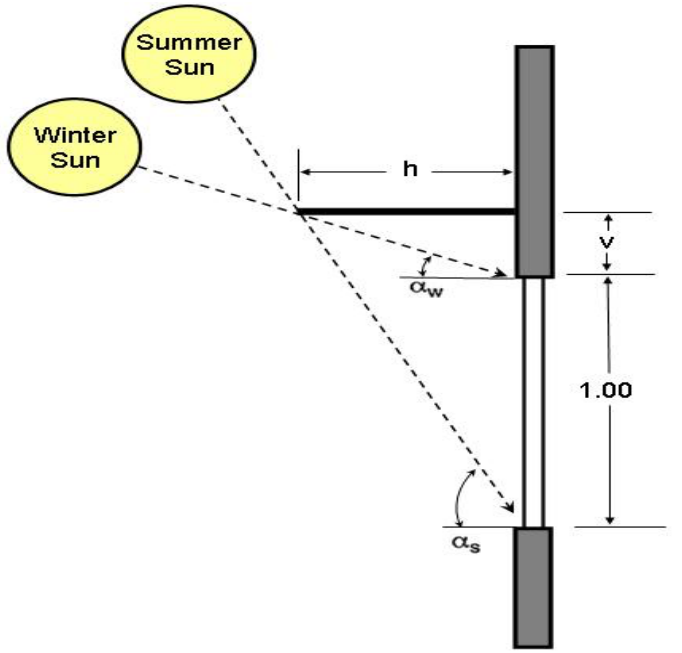


# Solutions

- Passive Building Design
- Advanced Evaporative Cooling Equipment
- “Integrated Design”

# Passive Buildings

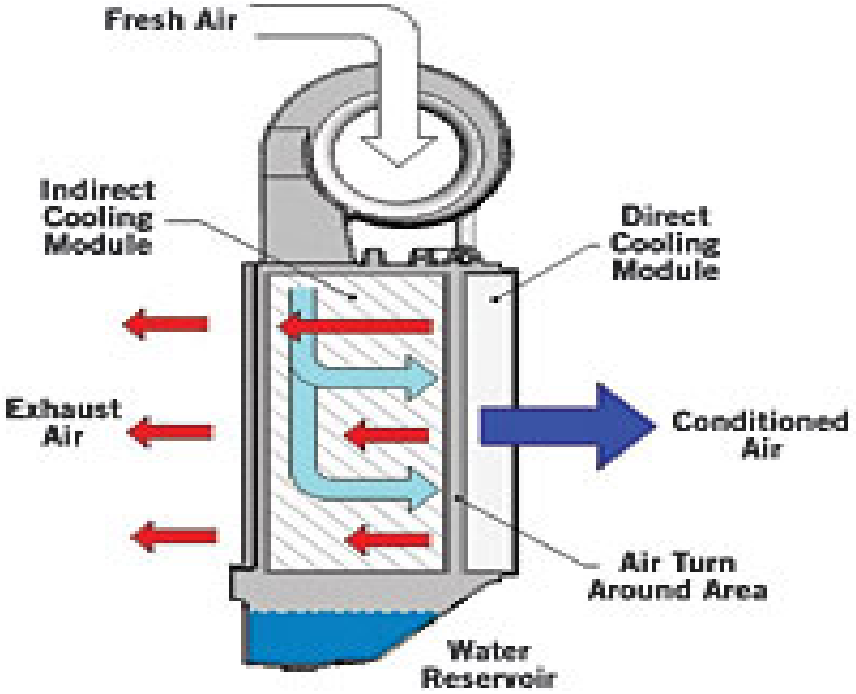
- Orientation, shading, overhangs
- Thermal mass (slab, double drywall)
- Design for night ventilation
- High performance windows
- Super insulation outside of mass
- Sealed envelope
- Insulated foundation




"h" and "v" are shading overhang dimensions, as a multiple of window height.

# Advanced Evaporative Cooling

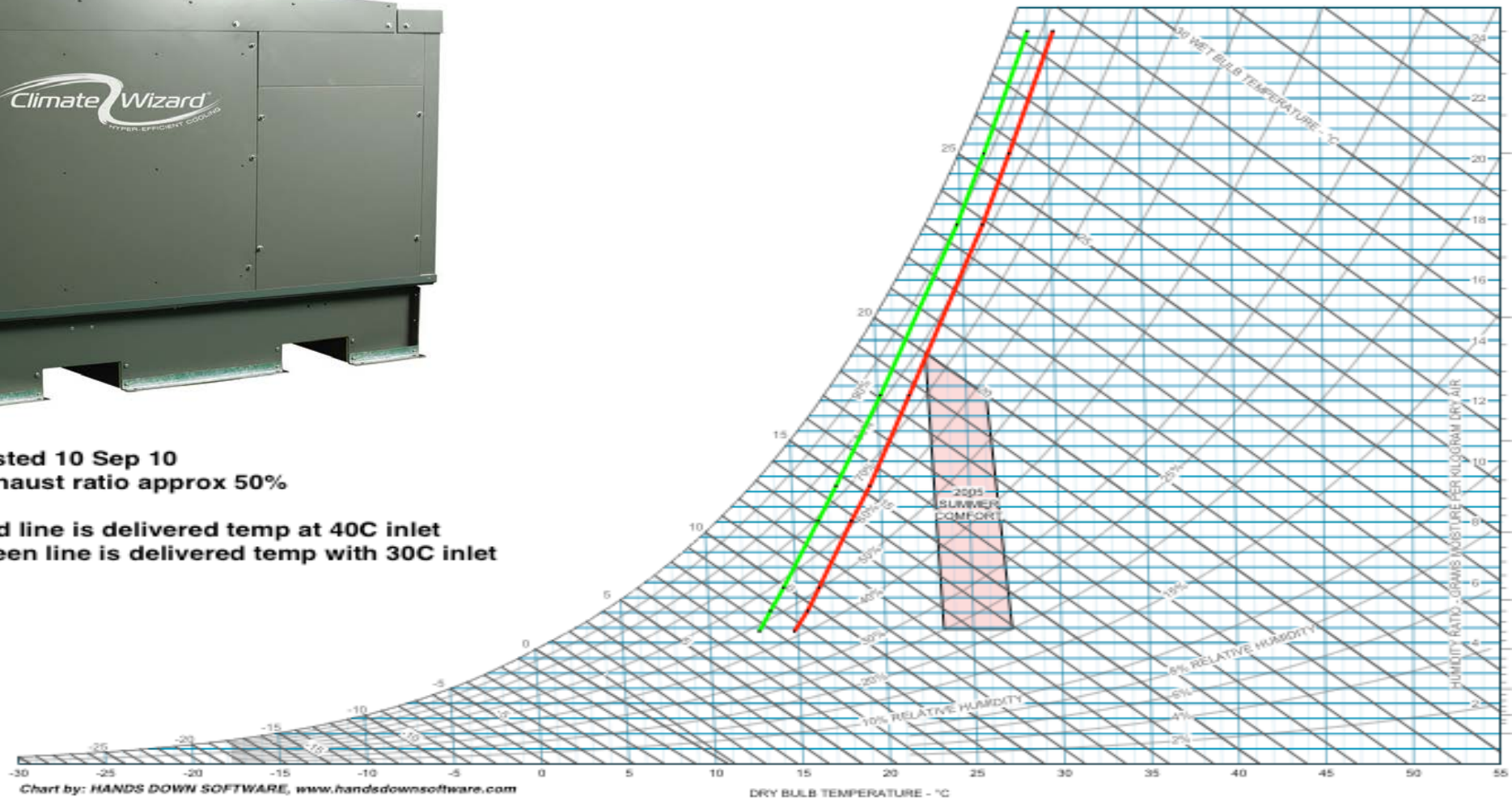
- “Direct” adds moisture to the air stream
- Modern direct coolers use rigid media
- “Indirect” cools air without adding moisture
- Three proven “indirect only” products available
- For Retrofit: DualCool hybrid/indirect



# Seeley Climate Wizard


**Tested 10 Sep 10**
**Exhaust ratio approx 50%**

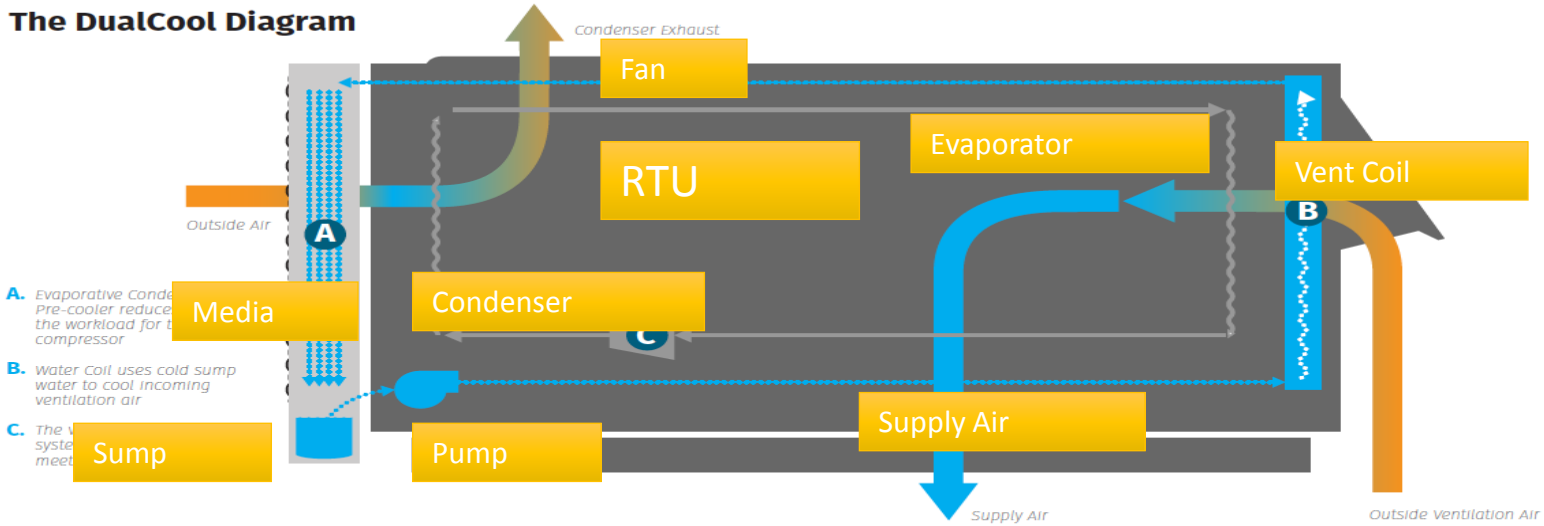
**Red line is delivered temp at 40C inlet**
**Green line is delivered temp with 30C inlet**



# DualCool Evaporative Pre-Cooling

- directly pre-cools condenser air
- indirectly pre-cools ventilation air

# DualCool




Background:

- Packaged cooling units (RTUs) provide cooling and fresh air
- RTU efficiency decreases with rising temperature
- Evaporative pre-cooling can significantly boost efficiency

DualCool Features:

- Direct evaporative section cools condenser air
- Recirculating water collects in sump
- Evaporative process cools air and water
- Pump sends water through vent air pre-cooling coil

# Residential Packaged Solutions

- Aquachill water-cooled AC
- Coolerado
- Climate Wizard coming soon

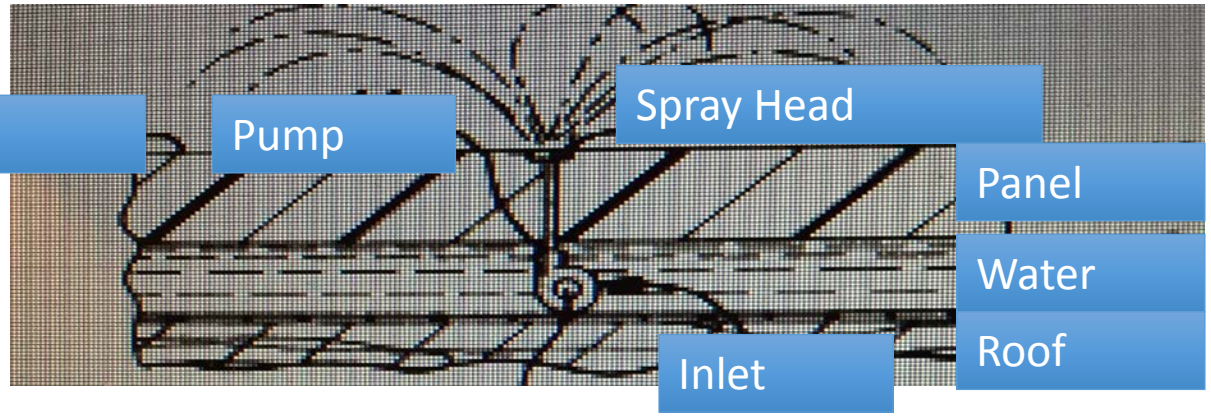
# Integrated Solutions

- Radiant Storage/Delivery
- NightSky Cooling
- NightSky “Triple Play”
- GeoHelix

# Night Roof Spray Storage Cooling

Basic Passive Version:

- Clear night sky is cold
- 9 cm water layer on flat roof
- Foam panels above water
- Pump sprays over panels
- Drains back through joints
- Water at 13C most mornings
- Cool passively or pump through heat exchangers




# Bourne House 1994

- 200 $m^2$ in Davis CA
- Radiant heating and cooling; no noise, no blower.
- Solar HW: 10 $m^2$, 2000 liters
- Passive mass: 8000 liters on roof, 20 cm first floor slab
- PV: 1.6 kW, time-of-use rate
- Energy: cooling $3/month; electric $100/yr gas $200/yr

# NightSky Cooling Version 2: Off-Roof Storage

Version 1 challenges:

- Codes limit “dead level”
- Fear of water layer on roof
- Tough to add penetrations
- Debris under panels

Version 2 Features:

- Uses roof drain system
- Drains water through filter
- Large tank below roof
- Controlled cooling delivery

# All Weather Factory: Ultimate Off-Peak Cooling

- Built by All-Weather Manufacturing, Vacaville CA
- 20 year-old building with award-winning NightSky installation
- Reduces cooling energy use by 70% & peak demand by 87%

Tilt-up with barrel-roof offices

Clerestory over production space

# NightSky Version 2: Status

- 6 projects completed
- 1999 ASHRAE award
- Top LEED performance
- Integrates with chiller
- Not being marketed

Lessons/Market Path:

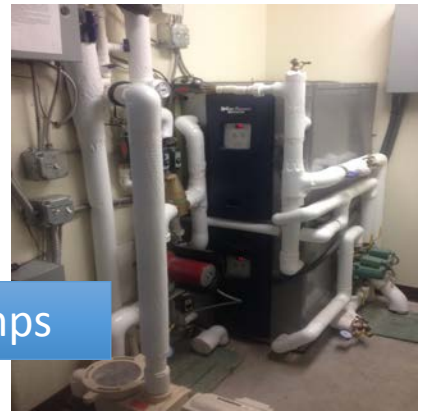
- Challenge to package
- Triple Play: Synergistic cooling, PV washing, rainwater collection

Parkview Place Davis

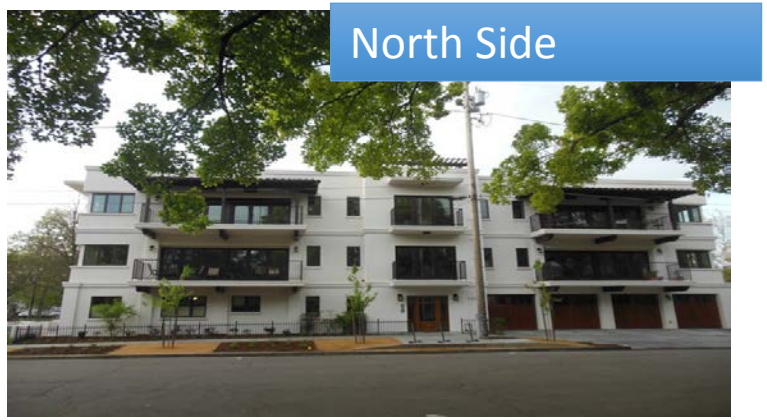
# Parkview Place Davis

- Owner-built, NZE, LEED Platinum apartment
- Uses GeoHelix, NightSky, SunPower PV
- Completed 2013; 15% kWh surplus
- All radiant: heating and cooling from floors
- Highest multi-family LEED score

Radiant tubing



Heat Pumps



North Side

# Parkview Place Davis

# GeoHelix Ground Exchanger

Rationale:

- True ZNE requires all-electric
- GEO most efficient option
- Deep-bore GHP too costly
- ZNE EE technologies beat PV

GeoHelix Features:

- Fits in 60 cm augered hole
- Packaged tight for shipping
- Expanded before placement
- Multiple bores in parallel

# GeoHelix Photos

# The Western Cooling Efficiency Center at UC Davis

- Launched in 2007, employs 24
- An element of the UC Davis Energy Efficiency Centee
- Now in 11th year; directed by Dr. Mark Modera
- Initial goal: advance (dry) climate-appropriate cooling
- Support from California Energy Commission, utilities, manufacturers, building owners
- Partners with industry, conducts research, develops standards
- See newsletters at website: www.wcec.ucdavis.edu

# Some WCEC Activities

- Western Cooling Challenge: certifies packaged AC units meeting dry climate standards
- Annual Affiliates Forum
- R&D:
  - Condenser Evap Pre-Cooling
  - Water Management for Evaporative Systems
  - Radiant Cooling from Ceilings
  - Aero-Sealing of Buildings
- ASHRAE Pre-cooler Standards

# La limite, c’est le ciel

In the coming world of ZNE:

- “The sky is the limit” for dry climate cooling technologies
- New construction offers major opportunities for integrated solutions
- Packaged solutions will continue to be needed for retrofit applications

# Merci de votre attention
# Avez-vous des questions?

**Dick Bourne**
**ICI**