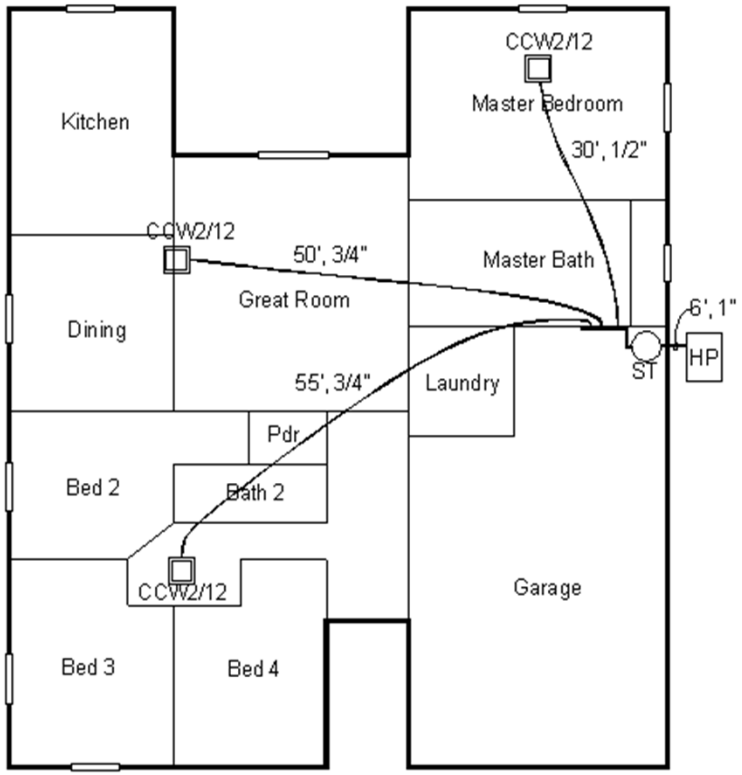

DUCTLESS HYDRONIC DISTRIBUTION

Alliance for Residential Building Innovation
David Springer, Davis Energy Group

Context

- Target: Builders of high performance new homes & deep retrofits
- Why is this technology key to meeting performance goals of future homes?
  - Distribution Efficiency
    - Distribution efficiency for well insulated, tight ducts in attics ≈ 85%
    - Duct energy losses drives placement of ducts inside conditioned space, which adds cost and interferes with structure and architecture
    - Ductless hydronic systems can approach 100% distribution efficiency; piping needs little space
  - Delivery Energy
    - Fans: 0.58 W/cfm or 9 (heating) to 27 (cooling) W/kBtuh
    - Pumps: 8 W/gpm, or 0.8 W/kBtuh

Alliance for Residential Building Innovation

Context

- Sizing
  - Conventional systems tend to be too large for low load homes
  - Thermal storage allows hydronic systems to have variable capacity
- Addresses future changes in refrigerant regulations (GWP reductions)

Alliance for Residential Building Innovation

Technical Approach

- A design and cost estimates were completed for a typical system using distributed small fan coils
- Feasibility was evaluated using TRNSYS models
- Two field tests are underway with radiant distribution – others planned
- Application issues: climate, building type, etc.
- Unresolved areas
  - Limited compact air handler products
  - High cost of chilled water sources for heating/cooling climates
  - Trade conflicts & training

Alliance for Residential Building Innovation

Simulated Energy Use

Air-to-Water Heat Pump with Forced Air Distribution

TRNSYS-estimated annual site heating & cooling energy use for selected climates

	Sacramento		Houston		Phoenix		Denver	
Energy Use (kWh/yr)	**Base Case**	**Ductless Hydronic**	**Base Case**	**Ductless Hydronic**	**Base Case**	**Ductless Hydronic**	**Base Case**	**Ductless Hydronic**
Heat Pump Heating	7,574	5,690	3,838	3,153	2,996	2,333	12,679	9,316
Heat Pump Cooling	1,229	1,195	4,238	4,057	8,293	7,819	570	589
Fan and Pump	1,470	609	1,367	769	2,625	973	1,260	746
Total	10,273	7,494	9,443	7,979	13,914	11,125	14,509	10,651
% Savings		27%		16%		20%		27%

Recommended Guidance

- Applications
  - Hot-dry and cold climates: radiant distribution on first floor, forced air on second floor
  - Humid climates: forced air distribution only
- Engineering is required for sizing & layout of components (including storage) and controls
- Contractors should be familiar with "wet" systems
- Utilize small air handlers with short duct runs until lower cost cassette type units become available

Alliance for Residential Building Innovation

Value

- Practitioners
  - Builders: Lower cost to achieve higher distribution efficiencies; simpler construction (no duct chases)
  - Contractors: Fewer callbacks due to comfort issues resulting from duct restrictions & air balance, duct losses, noise
- End users
  - Lower energy costs through improved distribution efficiency, and in some cases improved equipment performance by using thermal storage to shift times of operation
  - More usable space
  - Comfort through improved zone control

Alliance for Residential Building Innovation

Market Readiness

- What evidence is there that hydronic distribution can be successfully applied in new and existing homes?
  - Pipes are as common in residential buildings as ducts
  - Equipment is available now, and with recognition of the value and increased demand, equipment availability and costs should improve
  - The popularity of combined hydronic systems can lead the way to a more aggressive approach that eliminates ducts
- But more work is needed
  - Develop standardized designs
  - Installer training & certification
  - Better/more/lower cost product offerings

Alliance for Residential Building Innovation

Pros and Cons

- Pros
  - Efficient heating/cooling energy production and distribution
  - Improved comfort
  - More architectural and structural freedom
  - Addresses likely trend toward single package systems and elimination of refrigerant piping when low GWP refrigerants are mandated
  - No combustion safety issues
  - Demand-response potential
- Cons
  - Current cost constraints
  - Need for engineering
  - Limited equipment availability
  - More filters to change
  - Requires cooperation between plumbing & HVAC trades
  - Lack of design & installation guidelines and training programs

Alliance for Residential Building Innovation

References

- Springer, D., B. Dakin, C. Backman. 2012. A Feasibility Study: Ductless Hydronic Distribution Systems with Fan Coil Delivery. Building America project report completed by the Alliance for Residential Building Innovation (ARBI).
- Vineyard, E.A., R.L. Linkous. 2000. "Field Evaluation of a Residential Hydronic Distribution System in the Cooling Mode." ASHRAE Transactions vol. 106, pt. 2.
- ASHRAE Standard 152: Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Systems
- CEC 2011. "Proposed Compliance Option for Altherma Air-to-Water Source Heat Pump for the Residential Energy Efficiency Standards." California Energy Commission report number CEC-400-2011-010-SD
- Springer, D., M. Eastment, B. Dakin, L. Rainer, E. Hancock. 2007. Comparative Performance of Four Prototype Mechanical Systems in a Desert Climate. ASHRAE Transactions Vol. 114, Part 2. 2007.

Alliance for Residential Building Innovation