Building America Technical Update Meeting

Denver, Colorado April 30, 2013

Jordan Dentz, The Levy Partnership., Inc.

Closing Gaps in Modeling Multifamily Retrofits

ARIES Collaborative

Building America U.S. Department of Energy

Advanced Residential Integrated Energy Solutions

Overview

- Multifamily modeling inputs (BA House Simulation Protocols)
- Important multifamily measures
- Other MF gaps

Vital to meet 50% goals and therefore important to include in Building America's multifamily modeling capabilities

ARIES Collaborative

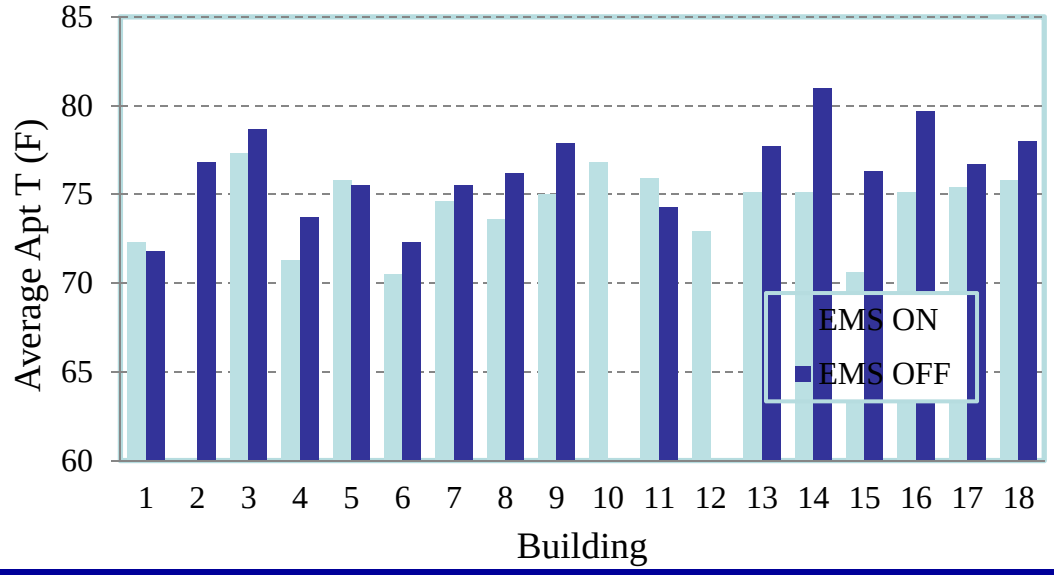
Model Inputs

- Heating set point
- Cooling set point
- Behavior assumptions

ARIES Collaborative

Heating Set Point – Central Systems

- House simulation protocol assumes 71°F
- Overheating is common
- Approach: adjust modeled heating set point – how much?
- Average heating season indoor temperature was 76°F in a sample of 18 buildings (ARIES 2013a)



ARIES Collaborative

Cooling Set Point – Room AC

- House simulation protocol assumes 76°F
- Room ACs used differently than central AC: only when and where needed
- Turn on/off rather than set point control
- Often only a portion of the apartment
- Approach:
  - Increase set point
  - Schedule cooling hours

ARIES Collaborative

Behavior

- Behaviors can differ dramatically, e.g. elderly housing or low-income
- Lack of resident set point control
- Split or missing incentives (i.e. where the residents don't pay for heat or aren't submetered)

ARIES Collaborative

Multifamily Retrofit Measures

- Multifamily buildings (especially those with central systems) have characteristics that lead to energy retrofit priorities different from single family homes.

ARIES Collaborative

Multifamily Retrofit Measures

- Enclosure measures often difficult and sometimes less productive
  - Masonry
  - Historic and zoning issues
  - Desire to avoid disrupting tenants
  - Smaller share of load

ARIES Collaborative

Multifamily Retrofit Measures

- Other opportunities:
  - Central mechanical systems large energy users
  - Distribution losses greater
  - Overheating/ imbalances common

Vital to meeting 50% goals and therefore important to include in Building America's multifamily modeling capabilities

ARIES Collaborative

Multifamily Retrofit Measures

- But are difficult to model in BEopt:
  - Boiler controls
  - Central heating distribution improvements
  - CDHW controls

ARIES Collaborative

Boiler Controls

Measure	Cost	Market penetration	Energy Savings	Supporting Research	Modeling approaches
Boiler controls – outdoor reset	$500 (adjust)-5,000 (new)	Common; large opportunity to tune/ upgrade	10-15% heating energy	PARR 2012, ARIES 2013b	Reduce overheating and/or adjust boiler efficiency
Boiler controls with Indoor temperature -input (EMS)	$5,000-$20,000	Moderate in some markets	Perhaps up to 20% heating energy	ARIES 2013b, PARR 2012	Reduce overheating to indoor cutoff

ARIES Collaborative

Central System Distribution Improvements

Measure	Cost	Market penetration	Energy Savings	Supporting Research	Modeling approaches
Steam balancing (venting, orifices, etc.)	$5,000-$10,000 for 15-30 unit bldgs.	Common?	Up to 25% heating energy	PARR 2012, Peterson 1985	Reduce overheating
TRVs	$50 - $250 per radiator	Modest in residential	Up to 15% heating energy	Rieger 1996, Xu et. al. 2008	Reduce overheating

ARIES Collaborative

Central DHW Controls

Measure	Cost	Market penetration	Energy Savings	Supporting research	Modeling approaches
CDHW Demand Control and/or Temperature Modulation	$3,000 to $5,000	Emerging; mostly California	Up to 15-25% DHW energy	(NYSERDA 1999), (Heschong Mahone Group 2006), (Enovative Kontrol Systems 2008-2010) and others	Reduction factor on DHW or lower DHW set point temp. Unknown factor will vary by building.

Evaluation complicated by interactive effects with space heating and cooling; dependent on climate, building configuration, and space heating and cooling system controls

ARIES Collaborative

BA HSP Building Type Definition

- The Benchmark may be applied to either a single-family or multifamily home (NREL 2010).
  1. Single-family: contained within walls that go from basement/ground to roof.
  2. Single-family attached: single-family home sharing a wall(s) with another unit (e.g. duplexes, row houses, townhomes).
  3. Multifamily: Units share a floor or ceiling with another unit. *The building must have at least five housing units but no more than three stories.*
- Definitions consistent with U.S. Department of Energy Residential Energy Consumption Survey (RECS) database (except the requirement on the number of units).
- **What about 2 and 3 family homes with one unit per floor: triple-deckers, brownstones, etc.?**

ARIES Collaborative

More Multifamily Gaps

- Modeling of whole building (as opposed to individual apartments) – but occupancy is limited by 5 bedroom max and appliances are limited to one set
- Modeling of individual apartments made more difficult by inability to model adiabatic floors and ceilings (we use R-100+)
- Modeling of partial adiabatic walls impossible – we average U-values

ARIES Collaborative

References

- (ARIES 2013). Hydronic Heating Retrofits for Low-Rise Multifamily Buildings, Jordan Dentz, Hugh Henderson and Kapil Varshney, ARIES Collaborative, forthcoming 2013.
- (ARIES 2013). Overheating in Hot Water and Steam Heated Multifamily Buildings, Jordan Dentz, Hugh Henderson and Kapil Varshney, ARIES Collaborative, forthcoming 2013.
- (Enovative Kontrol Systems 2008-2010). Case studies of: Oxford Club Apartments; Pepperdine University; Welk Resorts; William Penn Apartments, Los Angeles, CA; Equity Residential, Irvine, CA, Enovative Kontrol Systems 2008-2010.
- (Heschong Mahone Group 2006). Measure Information Template - Central Hot Water Distribution Systems in Multifamily Buildings - 2008 California Building Energy Efficiency Standards, Heschong Mahone Group, June 23, 2006.
- (Lovins 1992). Air Conditioning Comfort: Behavioral and Cultural Issues, Lovins, Amory B., E-Soource, Inc., 1992.
- (NREL 2010). Building America House Simulation Protocols, Robert Hendron and Cheryn Engebrecht, National Renewable Energy Laboratory, October 2010.
- (PARR 2012). Steam System Balancing and Tuning for Multifamily Residential Buildings in Chicagoland, Jayne Choi, Peter Ludwig, and Larry Brand Partnership for Advanced Residential Retrofit, August 2012.
- (Peterson 1985). Achieving Even Space Heating in Single Pipe Steam Buildings, A Joint Research Project of Minnegasco and the Minneapolis Energy Office, Peterson, G., 1985.
- (NYSERDA 1999). DHW Modeling: System Sizing and Selection Criteria, a Study of Baseloads and Seasonal Efficiency, New York State Energy Research and Development Authority, Final Report 99-2, January 1999.
- (Rieger 1996). Radiator Valves Prevent Apartment Overheating, Home Energy, Rieger, T., May/June 1996.
- (Xu et. al. 2008). Dynamic Simulation of Space Heating Systems with Radiators Controlled by TRVs in Buildings, Energy and Buildings 40 (9): 1755–1764, Xu, B.; Fu, L.; Di, H., 2008.

ARIES Collaborative