# MA Utility Study

## Ductless Mini-Split Heat Pump Impact Evaluation (MA/RI Util's, Cadmus)

http://ma-eeac.org/wordpress/wp-content/uploads/Ductless-Mini-Split-Heat-Pump-Impact-Evaluation.pdf

My take-aways from this study:

- Winter 2014-15 (cold with record-breaking snow)
  Median COP: 1.7 (134 systems)
- Winter 2015-16 (extremely mild with negligible snow)
  Median COP: 2.5 (91 systems)
- HUGE range in heating COPs (0.2 – 4.5)
- Multi-split systems performed considerably less efficiently than 1:1 mini splits

# Best Practices

Use appropriate equipment for the climate.

Refer to NEEP listing

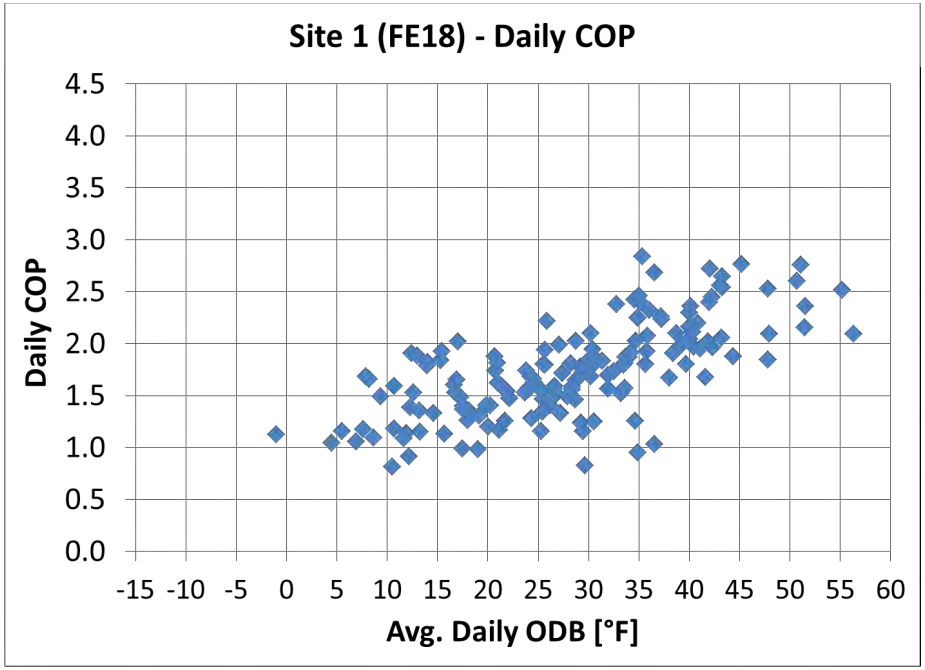
(and manufacturer lit)

http://www.neep.org/initiatives/high-efficiency-products/emerging-technologies/ashp/cold-climate-air-source-heat-pump

# Best Practices

Higher indoor air flow rates result in higher efficiencies, so…

- Don't oversize



# Best Practices

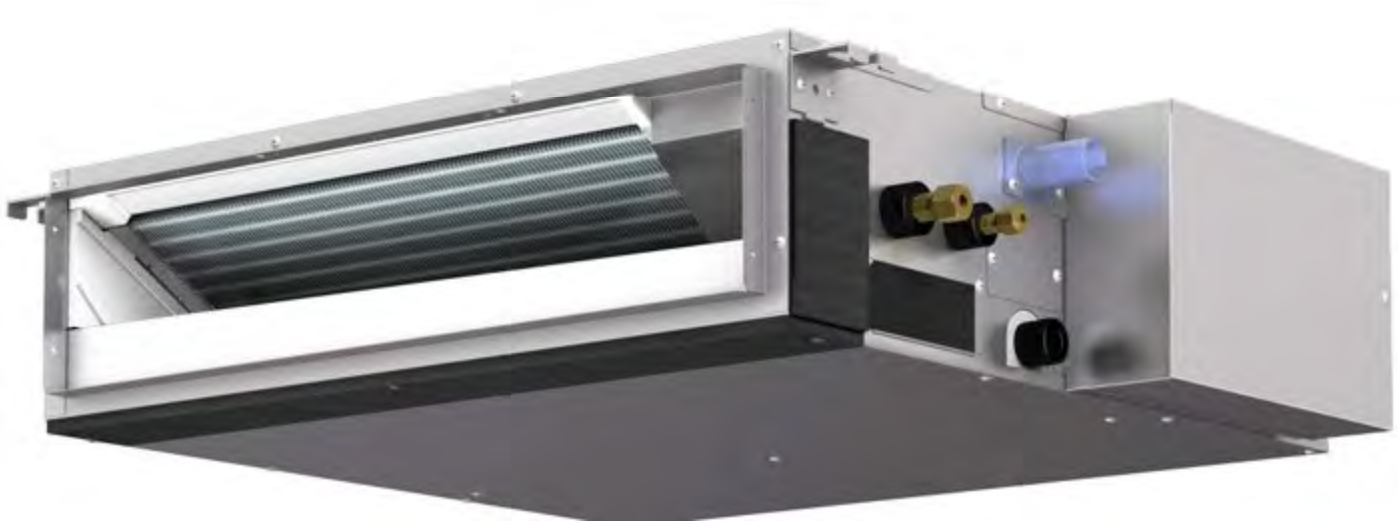
High return air temperatures lead to lower heating efficiencies, so…

- Consider floor/low-wall fan coils.

Image from Fujitsu

# Ducted Systems

May address flow rate and return temperature issues



# Outdoor Units

# Outdoor Units

# Stacked Outdoor Units

# Outdoor Unit

# Outdoor Unit

# Outdoor Units

# Outdoor Units

# Outdoor Units

# Outdoor Units

# Heating Costs

- Spreadsheet

# New, Low-Load Homes

- Single-family or Multi-family
- Single, low-cost H/C system

# Zero Energy

BrightBuilt Home, Kaplan Thompson Architects
Lincolnville, ME

# Zero Energy


Revival Homes
2015 winner of Connecticut “Zero Energy Challenge”
Litchfield, CT

# Best Practices

- Size properly
- In some low-load homes, ASHPs can be only heat source. Some homes use auxiliary resistance
- Consider ducted or low-wall fan coils for better heating efficiency
- Use climate-appropriate equipment (NEEP listing)
- Install indoor and outdoor units properly
- Proper control and operation

Questions?

Break?

# Average DHW Consumption

In a single-family home,

Old rule of thumb: 60-70 gallons per day

This is dropping!

Now: 30-45 gal/day more typical

# Option 1: Elec. Storage Tanks

- Better insulation now (some better than others)
- Low first cost
- Readily available
- (U)$EF_{min}$ ≈ 0.90 (50 gal)

# Resistance Tank Drawbacks

- Resistance is expensive to operate!
- Space
- Standby losses
  - Well-insulated tank
  - Use heat traps
  - Insulate pipes

If hot water use is really low, is electric resistance really that expensive…?

# Option 2: Tankless Electric

- No standby loss ~100% eff.
- Systems available with modulation & temp. control recommended (not staged elements).

Current Draw!
1 gpm: 9 kW, 40 A
4 gpm: 35 kW, 150 A
(240V, 60°F rise)
Cost: ~$1,000

# Tankless Electric

- Point of Use
- Still ~100% efficient, but lower dist. losses
- Still typ. 5-15 kW, 20-70 Amps

# Tankless Electric

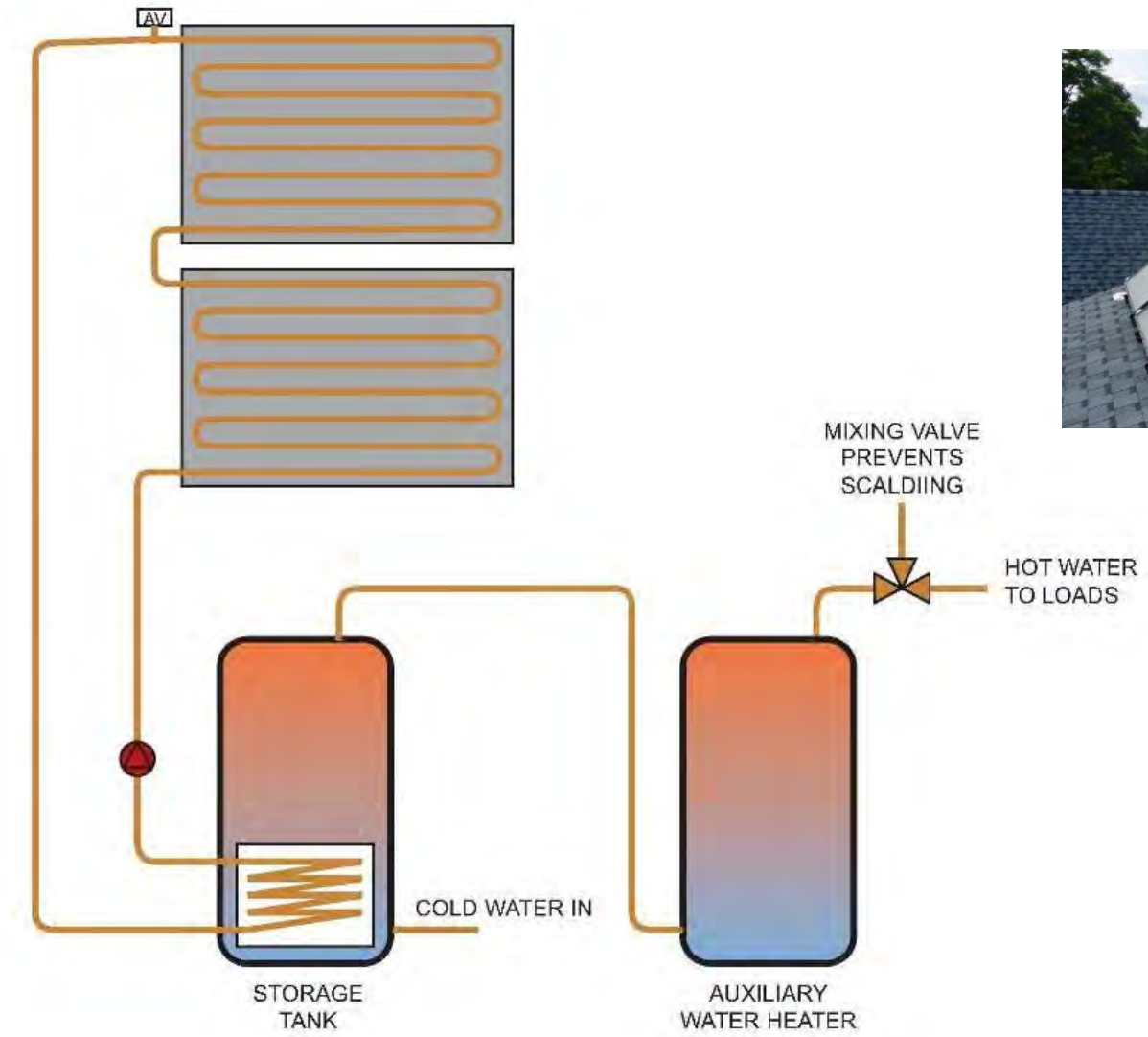
Advantages

- Low first cost
- No standby losses
- No distribution losses (point of use)
- Low space needs

Disadvantages

- Resistance still expensive
- CURRENT DRAW!

# Option 3: Solar Thermal




# Solar Thermal

- 50-80% of DHW load for a typical SF home
- High first cost: **$8,000-$12,000** for system with 60-90 $ft^2$ **before incentives**

Average cost of 79 two-collector systems installed in MA in 2015-16: **$10,121**

http://files.masscec.com/get-clean-energy/residential/commonwealth-solar-hot-water/ResidentialSHWProjectDatabase2016.xlsx

# Solar Thermal Incentives

- Federal tax credit (30%)
- Massachusetts CEC: 40% or $4,500 (SF)
  http://www.masscec.com/get-clean-energy/residential/solar-hot-water
- MA State tax incentives

- Check dsire for more info:

dsireusa.org

# Solar Thermal

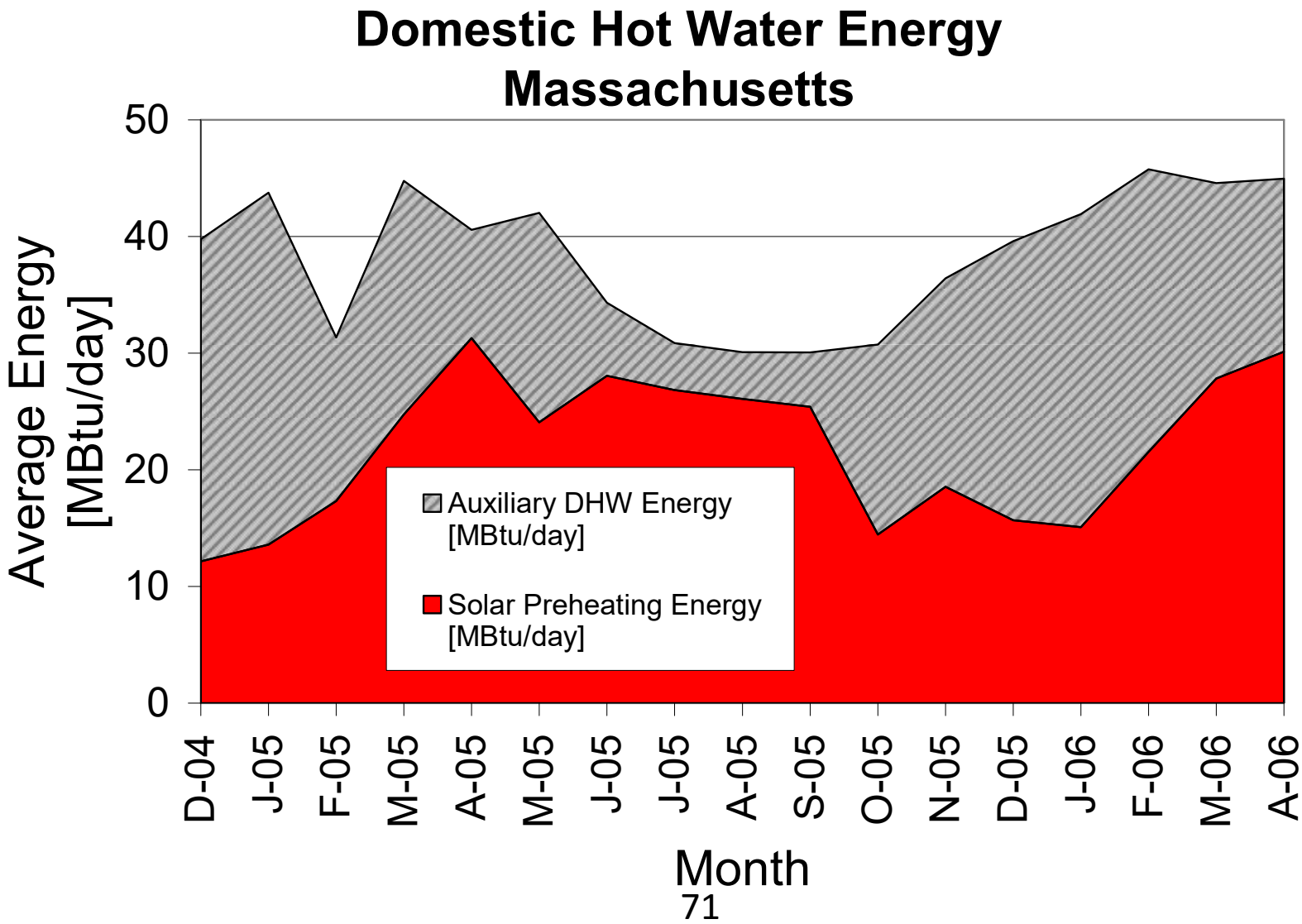
## Western MA

- Two, 32-ft$^2$ flat-plate collectors
- 80-gallon storage tank

**Hot Water Use: 64 gal/day**

**Annual Solar Fraction: 61%**

# Solar Thermal



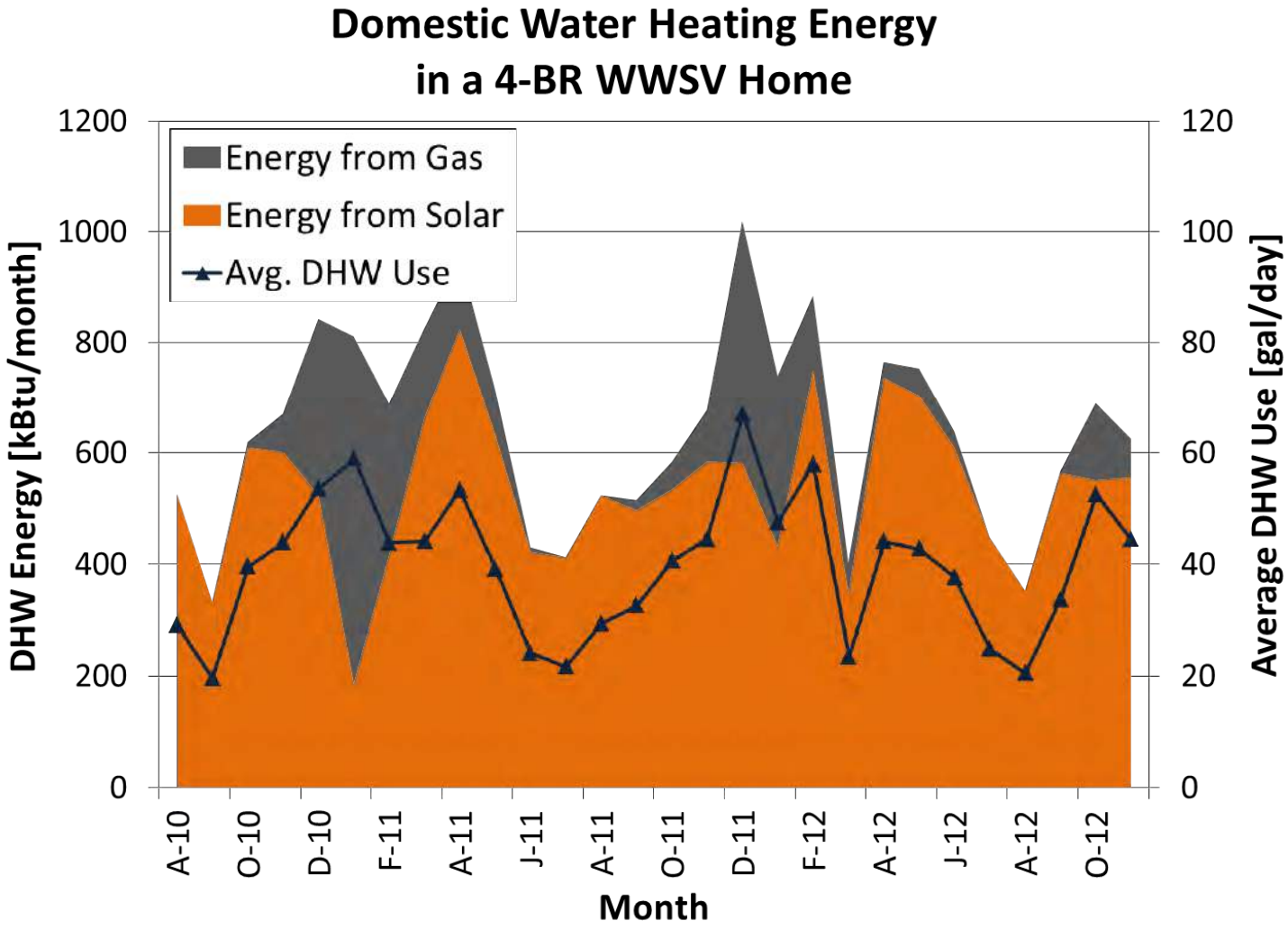
# Solar Thermal

- 90 $ft^2$ flat plate collector
- 110 gallon storage

**Hot Water Use: 39 gal/day**
**Annual Solar Fraction: 80%**

Greenfield, MA

# Greenfield Solar Performance



# Greenfield Solar Economics

Installed cost: **$9,600**
(before incentives)

- 80% solar fraction
- 40 gal/day

Ann gas use: 24 therms

Ann cost ($1.40/therm): **$34**

Annual Solar Savings:

- 88 therms, **$123**

Solar DHW on SF homes with efficient gas WH & modest water usage… economics aren't great.

# What about an Elec. Home?

With an Elec. Resist tank,

Cost of heating 40 gal/day

- 2,700 kWh/y, **$513** ($0.19/kWh)

With Solar Thermal (80% solar fraction)

- Savings of 2,160 kWh, **$410**/y

Is that worth **$9,600**?

…or ~**$3,000** after incentives?

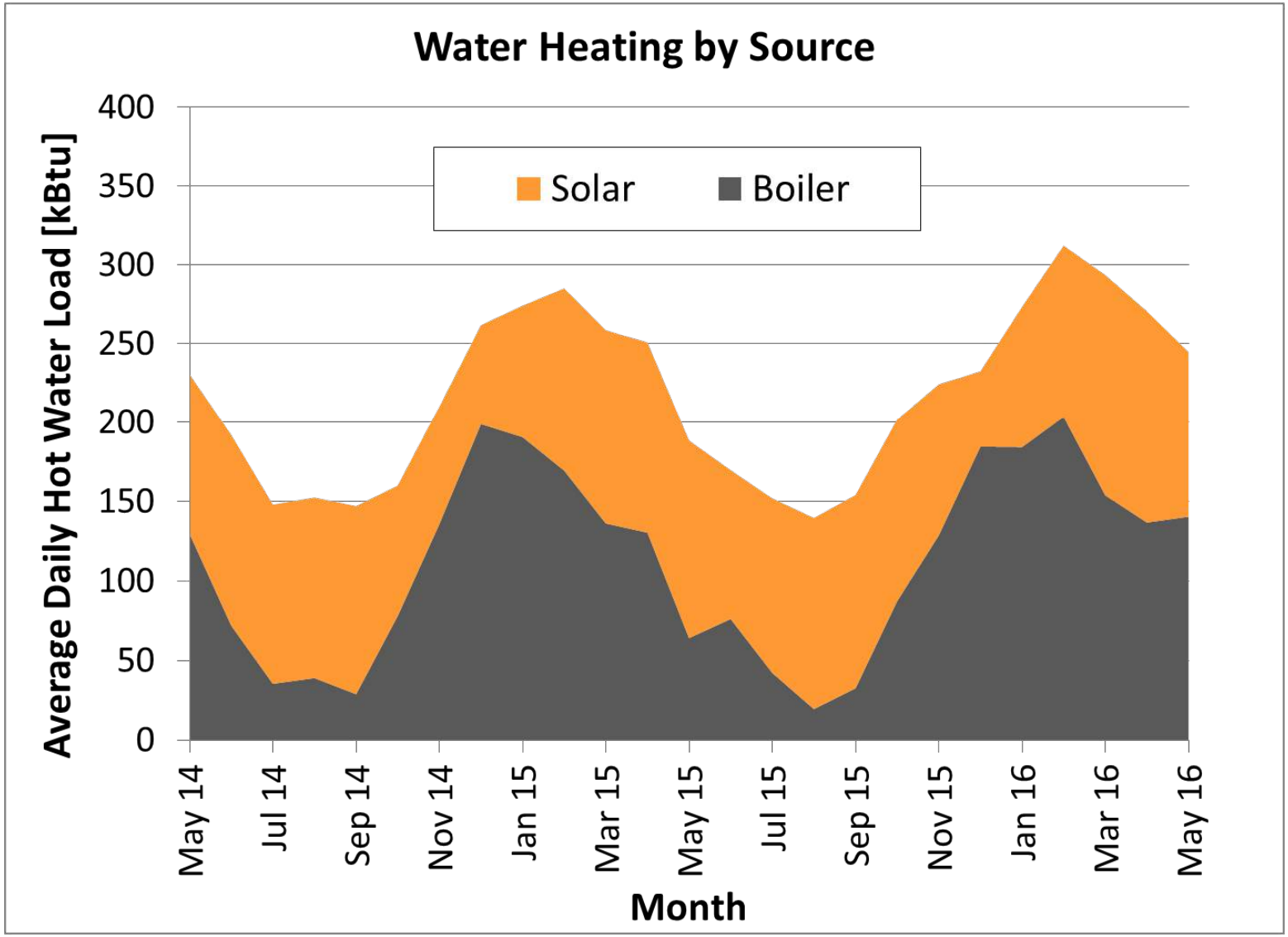
# Multifamily Solar DHW

- Higher consumption
- Better scale (lower $/unit)
- Load diversity

# Multifamily Solar Thermal

- Installed cost: ~$31,000
- 372 $ft^2$ evac. tube collectors
- 3 Major incentives
  - State rebate
  - Federal tax credit
  - Accel. depreciation
- ~$9,000 (pres. value) after incentives

# MF Solar Performance



# Solar Costs & Benefits

Hot Water use: ~20 gal/unit-day

| | |
|---|---|
| **Gas** cost w/o solar: | $1,000/y |
| w/ solar: | $ 300/y |
| Solar savings: | **$ 700/y** |

| | |
|---|---|
| **Elec.** cost w/o solar: | $3,600/y |
| w/ solar: | $1,100/y |
| Solar savings: | **$2,500/y** |

Costs: $31,000 before; ~$9,000 after incentives

http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/conwayst-apartments-multifamily-retrofit.pdf

# Solar for Multifamily

- CA study found MF solar cost **28%** less than SF solar costs (per $ft^2$ collector)
  http://www.cpuc.ca.gov/NR/rdonlyres/C1C7FD10-05AA-493B-8CD0-F2C24DCA955A/0/CCSE_SWHPP_Rpt.pdf
- Better scale for installation, piping, storage tanks, O&M, load, etc.
- Rule of thumb: installed cost **~$100/$ft^2$** of collector area
  (Greenfield system **$83/$ft^2$**)
- Better scale for load as well as costs