REDWOOD ENERGY

Build It Green

Shifting Peak Loads in ZNE Housing

Modifying the California Energy Commission (CEC)'s Simulation Engine (CSE) to prototype peak load shifting strategies in ZNE housing.

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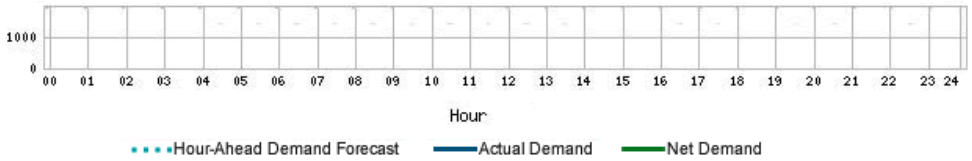
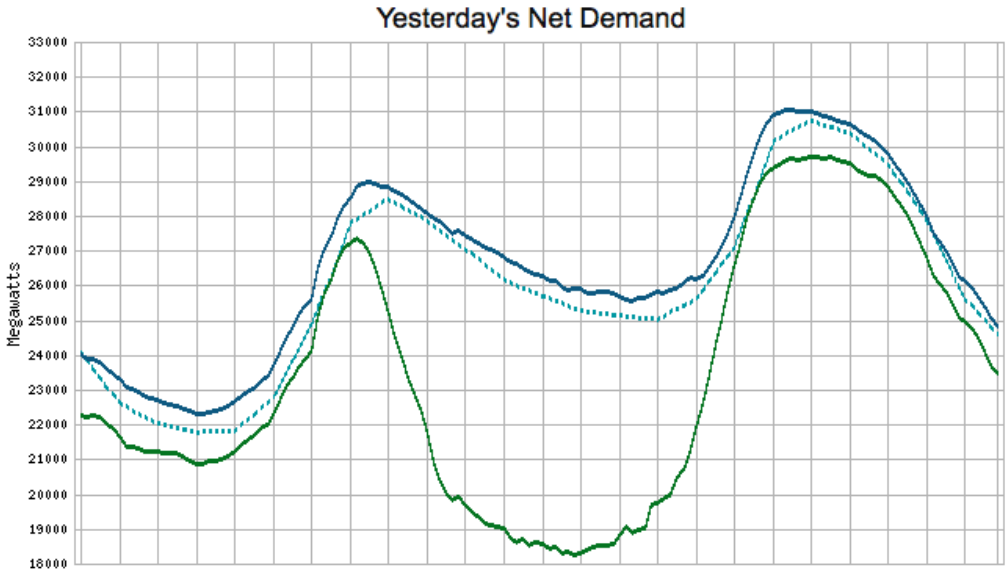
Thanks to: Jenna Bader, Maria Diaz

Motivation

- Why shift the peak loading?
- Distributing solar thermal resources over time
- Issues with TDV as a measurement within software
  - Model assumes operation at peak times
    - Result is to favor natural gas over all electric





http://www.caiso.com/outlook/SystemStatus.html (1/23/17)

Outline

General Grant information

Redwood Energy's areas of research

How we are approaching the research

EPIC Grant Partners

Build it Green

Association for Energy Affordability

Redwood Energy

Nexi (Propelsion)

Stone Energy Associates

Lawrence Berkeley National Laboratory

Corporation for Better Housing

Resources for Community Development

Grant Background Info

This Agreement will lead to ***technological advancement*** and ***breakthroughs*** to overcome barriers to the achievement of the State of California's statutory energy goals in the following manner:

- **Water heating**: central versus individual heat pump systems
- **Storage**: Evaluate the potential for thermal storage solutions
- **Code compliance**: Develop new analysis algorithms for thermal storage & complement, make use of planned field work and data

Areas of Research

1. Varying set point temperature on an hourly schedule to effect thermal storage

2. Reusing waste heat for heating water.
    - Heat exchanger for DHW to AC (vice versa)

3. Performance of high efficiency fixtures and appliances in ZNE housing.

Area of Research #1

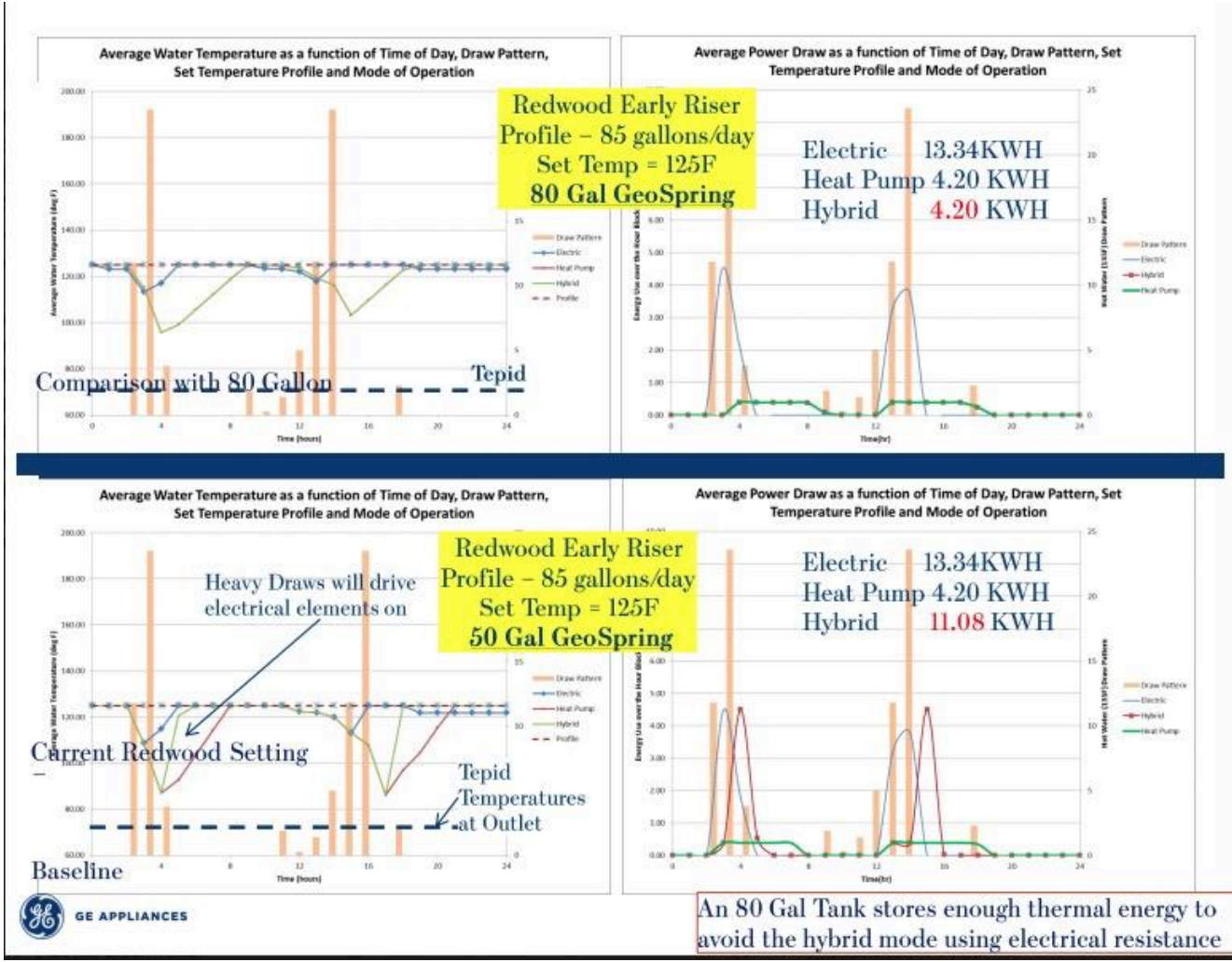
1. Varying setpoint temperature on an hourly schedule to effect thermal storage

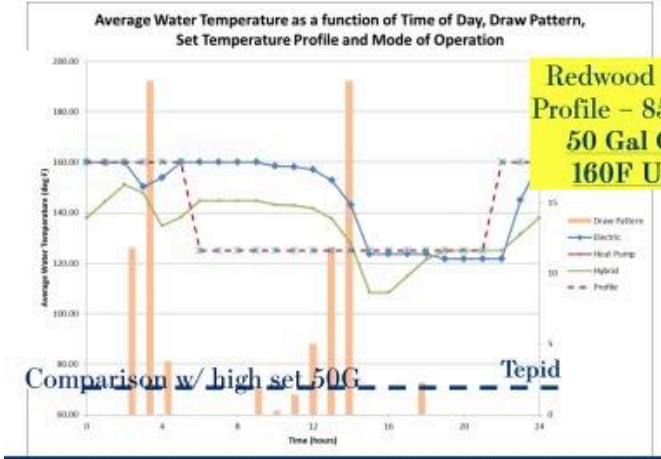
- For the R-134a refrigerant Rheem 50 gal tanks
  a. setpoint temp of 160ºF from 9am-1pm and 1am-5am
  b. 115ºF for all other time

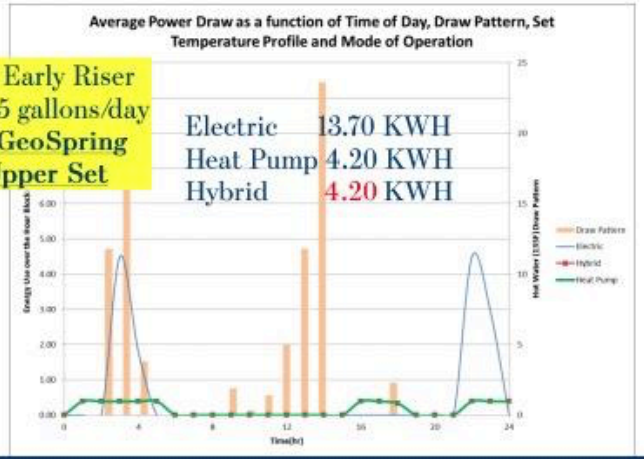
- For the R-410a refrigerant Aermec NRP central HVAC/DHW heat pumps
  a. we are limited to 131ºF

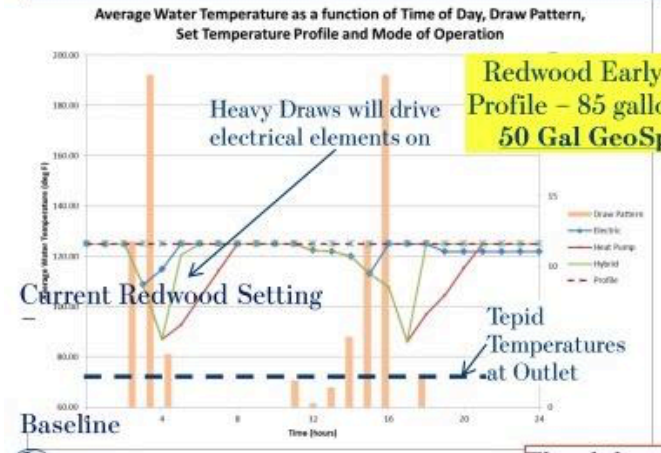
Research Scenario

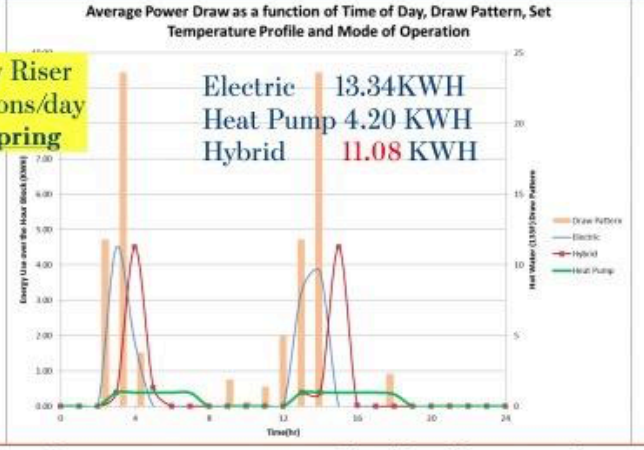
(GE GeoSpring, April 14, 2016)
Examples are 3br apartment data











GE APPLIANCES

The ability to adjust set temperatures of the 50 gallon provides similar energy use results to the 80 G, plus more available capacitance

Making Sense of These GeoSpring Data

	TEMPERATURE	
VOL	50G-125F: Hybrid engages resistance	80G-125F: Electric Resistance not engaged
	50G-160F: More available capacitance than 80 G	80G-160F: Electric Resistance not engaged

Hybrid tanks engage electric resistance heating at lower volume or higher set point temperature
Lower EF values expected when temperature set point raised
Higher EF value when tank volume is higher
-- All worthy of consideration in field testing and modeling going forward

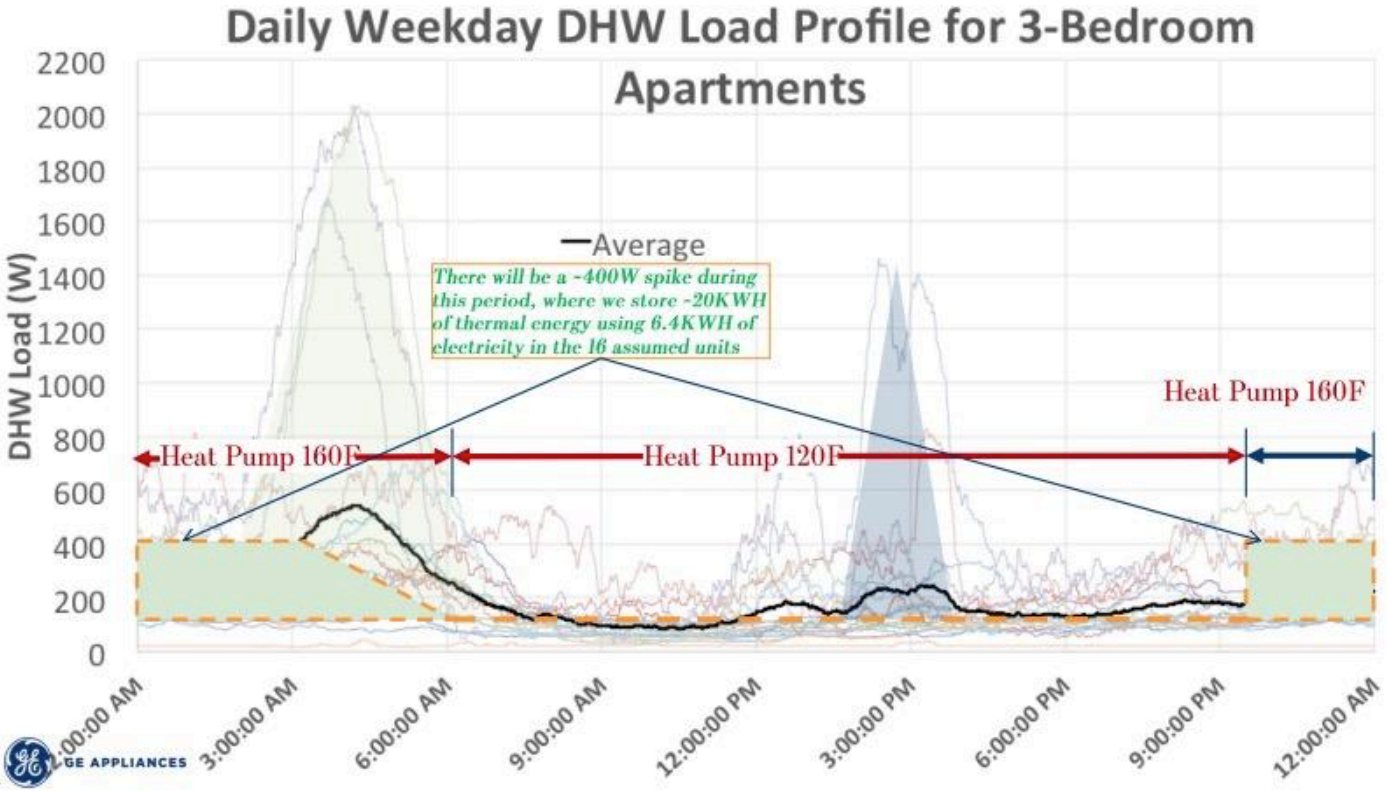
GeoSpring, Cont'd

* Simulate heat pump setpoint temperature within CSE.

* Study & illustrate how to use thermal storage to best effect in ZNE projects and overcome TDV scoring which doesn't accept solar offsets in 8760 hourly analysis

Moving Energy From "Time Dependent Valuation" towards "Time-inDependent Variable"

Proposal: Install GeoSprings with 160F or higher capability into all 3BR & 4BR apartments, then run in heat pump mode with set point changes to 160F from 10pm to 6am, then back to 120F



CEC Compliance Software (Approach to #1)

CBECC-RES Master Files

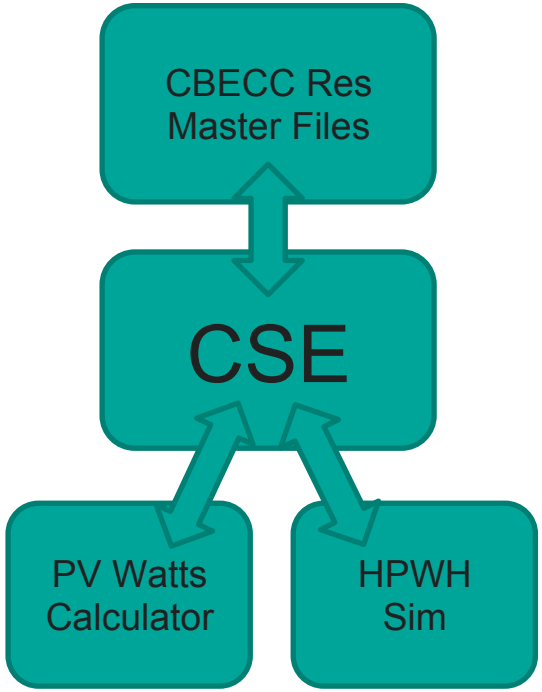
<u>CSE Engine</u>

Heat Pump Water Heater Simulator Engine

PV Watts Calculator

<u>Residential Alternative Calculation Method</u>

Documents the rules used for modeling residential buildings for performance compliance under California's 2016 Building Energy Efficiency Standards.



Our Approach:

Getting the code and familiarizing with the language and architecture.

C++ GitHub source forge Visual Studio

CBECC-Res (California Building Energy Code Compliance)

Source Code - Building data model and rules database

.cpp

.csv

.rule

.txt

.h

CBECC Res Master Files

CBECC-software / cbecc

bin	Initial public commit
doc	Add doc file on behalf of Scott Criswell
src	CBECCUI (889) tree view fix and improvements to Res analysis error di...
vendor	Initial public commit
.gitignore	Initial public commit
CREDITS.md	minor edits to credits page for readability
LICENSE.md	Initial public commit
README.md	Fix spelling error

cbecc / bin / Res / Rules / src / **Rules** /

- CAClimateZoneDHWASHPAdj.csv
- CAClimateZoneInletMainsTemp.csv
- CAHPIncTable.csv
- CAHPMultTable.csv
- CARes13_PeakDemand.csv
- CARes16_PeakDemand.csv
- CAResFileHashes.csv
- CAResKey.csv
- CARes_DHWTables.csv
- CEC 2016 Res TDV by CZ and Fuel.csv
- CEC 2019 Res TDV by CZ and Fuel.csv
- ClimateZone.txt
- DHWTankAreaCoefs.csv
- Rules_BudgetConversion.rule
- Rules_BudgetConversion_DHW.rule
- Rules_BudgetConversion_DHW_2013.rule
- Rules_CSE_Simulation.rule
- Rules_CSE_Simulation_Cons.rule
- Rules_CSE_Simulation_DHW.rule
- Rules_CSE_Simulation_HVAC.rule
- Rules_CSE_Simulation_IntMass.rule
- Rules_CSE_Simulation_PV.rule
- Rules_CSE_Simulation_Surfaces.rule
- Rules_CSE_Simulation_Zones-IntGains.rule
- Rules_Default.rule
- Rules_Default_Construction.rule
- Rules_Default_HVAC.rule

Rules_CSE_Simulation_DHW.rule

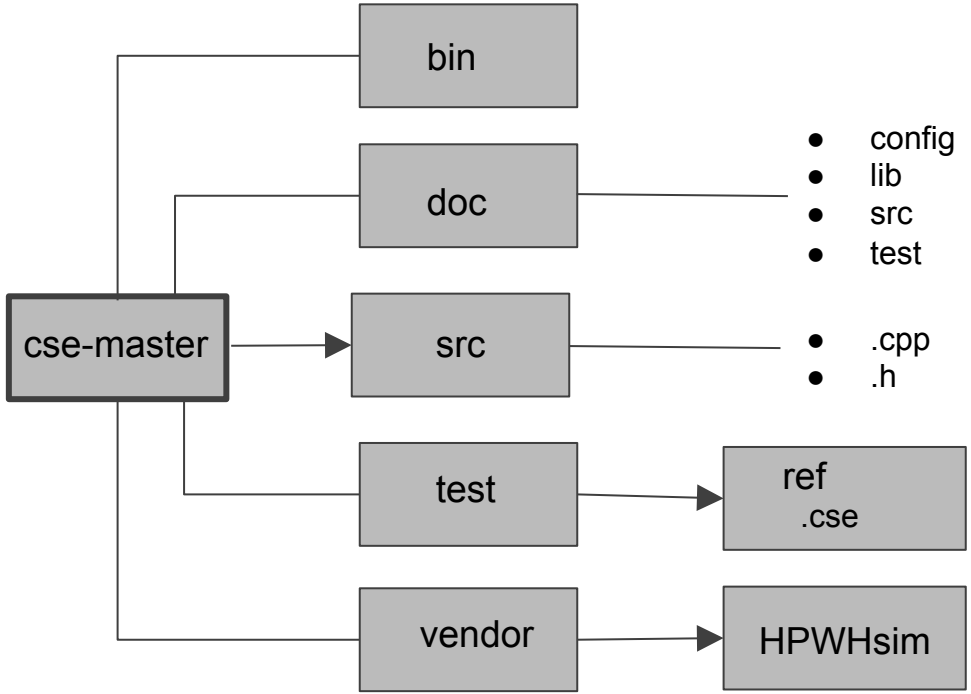
```
;*****************************************************************************************************
RULELIST "CSE_SimulationPrep_DHW" 1 0 0 1
;   Rules which are executed immediately prior to performing a CSE simulation - covering DHW objects only
;*****************************************************************************************************
; SAC 4/6/16 - added in conjunction w/ CSE 0.796 - related to new HPWH model

"
Set cseDHWSYS:wsTSetpoint"cseDHWSYS:wsTSetpoint = {if (Proj:CSEDHWUseMethod == 1) then UNDEFINED
                                                    else if (LocalCompAssigned( SourceDHWSys ) < 0.5) then
UNDEFINED
                    else 125  endif endif  }
                                                    else if (Proj:IsMultiFamily > 0.5 .AND.
SourceDHWSys:CentralDHW > 0.5)
                                then  130  else  125  endif endif endif  }
```

<u>Bill Wright, President. Wrightsoft Corporation</u>

- CBECC-Res uses hourly exports to retrieve energy use values from CSE and calculates TDV results from them
- Adapting the Heat Pump Water Heater Simulation Tool (wilcox website - CSE) to input an array of hourly value Setpoints instead of just one setpoint.

CSE Master Files



California Simulation Engine

https://github.com/cse-sim/cse/blob/master/src/DHWCalc.cpp

```
// DHWCalc.cpp -- Domestic Hot Water model implementation

Line 21          #include "hpwh/hpwh.hh"    // decls/defns for Ecotope heat pump water heater model
Line 1326        RC DHWHEATER::wh_HPWHInit()                    // initialize HPWH model

Line 1417         // setpoint temp: ws_tUse has hourly variability
                     //   some HPWHs (e.g. Sanden) have fixed setpoints, don't attempt
                     if (!wh_pHPWH->isSetpointFixed())
                       {
                #if 0 && defined _DEBUG
                                          static float tSetpointPrior = 0.f;
                     if (pWS->ws_tSetpoint != tSetpointPrior)
                                                   {          printf( "\nSetpoint change!");
                                                             tSetpointPrior = pWS->ws_tSetpoint;
                                                    }
                #endif
                                          wh_pHPWH->setSetpoint( DegFtoC( pWS->ws_tSetpoint));
                                          }
```

Heat Pump Water Heater Simulation

https://github.com/cse-sim/cse/tree/master/vendor/hpwh

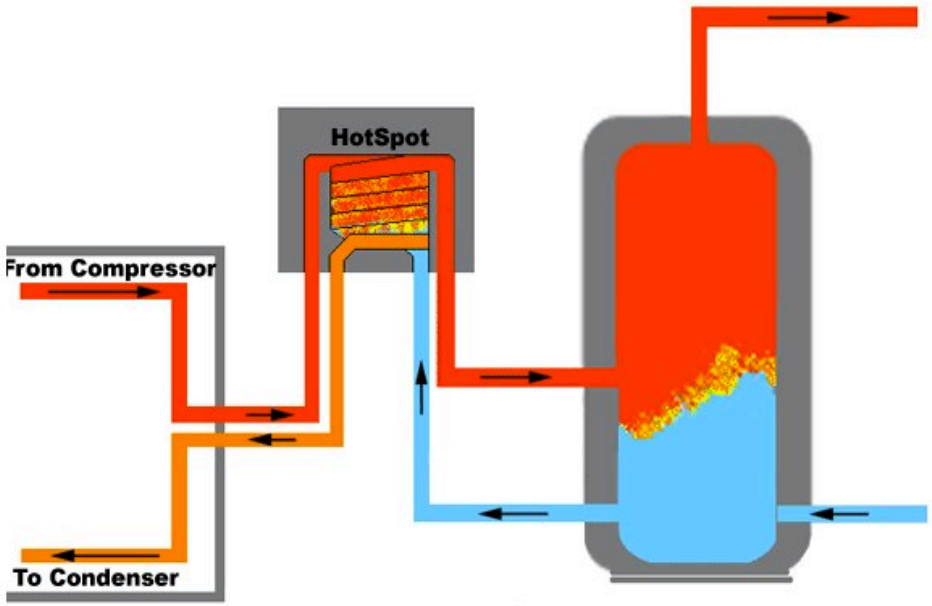
```
Line int HPWH::setSetpoint(double newSetpoint){
        if (setpointFixed == true) {
                if (hpwhVerbosity >= VRB_reluctant)msg("Unwilling to set setpoint for your
currently selected model.\n");
                return HPWH_ABORT;
        }
        else{
                setpoint_C = newSetpoint;
        }
        return 0;
```

Bruce A. Wilcox, P. E (Building Energy Efficiency Software Consortium)

- CSE will accept an array of setpoints for the internal HPWHsim, but this feature is not available in CBECC-Res since it is not needed for compliance calculations.
- For research purposes, run CBECC-Res and have CSE read the array of setpoints from a separate text file for use in simulating the HPWH.
- This would allow to put the array of setpoints in the HPWHsim and provide results in energy and TDV units.

Area of Research # 2

- Reusing “waste” heat from air conditioning unit for domestic hot water.
- Heat water while cooling the air
- Heat exchangers
  - Refrigerant
  - Shell and tube
- Desuperheating
  - Monitoring(Data)



Questions

For us and for you …

Suggestions