We will be starting soon!

Thanks for joining us

Home Electrification Planning Class 1: Soup to Nuts

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August 22, 2023

HOME ELECTRIFICATION PLANNING SERIES

Learn how to develop customized home electrification plans for customers or your own home!

Home Electrification Planning Classes

TODAY! Class 1: Electrification Planning: Soup to Nuts

- What is an electrification plan
- Importance of electrification planning
- Methods for calculating heating load

Aug 29 Class 2: Electrical Panel Optimization

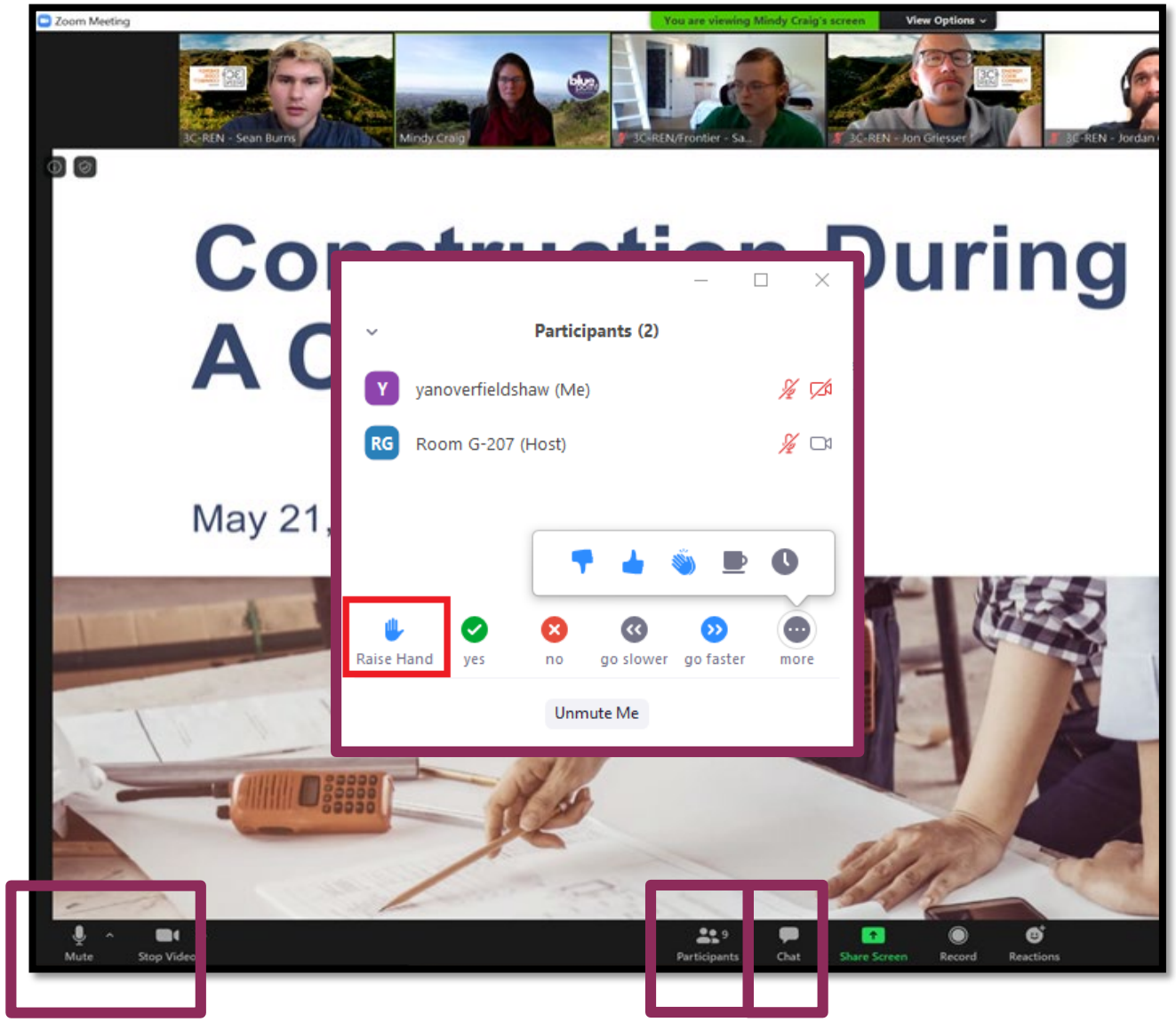
- How to calculate existing electrical load
- Incorporate planned electrification upgrades
- Optimize existing electrical panel capacity

Sept 5 Class 3: Developing an Electrification Plan

- Selecting proper type, sizing, and location for new equipment
- Essential components of an electrification plan
- Setting the homeowner and contractors up for success

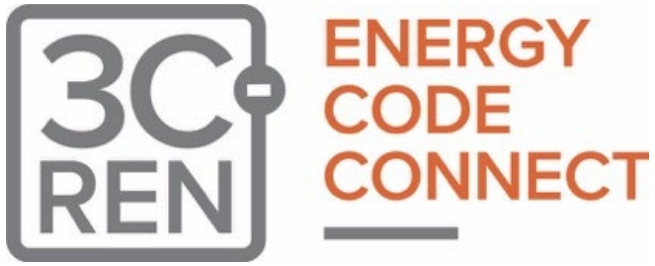
Zoom Orientation

- Please be sure your full name is displayed
- Please mute upon joining
- Use "Chat“ box to share questions or comments
- Under "Participant" select "Raise Hand" to share a question or comment verbally
- The session may be recorded and posted to 3C-REN's on-demand page. Feel free to ask questions via the chat and keep video off if you want to remain anonymous in the recording.



3C-REN: Tri-County Regional Energy Network

- Three counties working together to improve energy efficiency in the region
- Services for –
  - **Building Professionals:** industry events, training, and energy code compliance support
  - **Households:** free and discounted home upgrades
- Funded by ratepayer dollars that 3C-REN returns to the region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Home Electrification

THE IMPORTANCE OF A PLAN

Problems of Electrifying WITHOUT a Plan

- Homeowner's 1st electrification projects use up too many panel amps
- Advised by contractor who is not thinking about whole-home electrification
- Worst offenders:
  - 50-amp car chargers
  - 50-amp HVAC systems

Problems of Electrifying WITHOUT a Plan

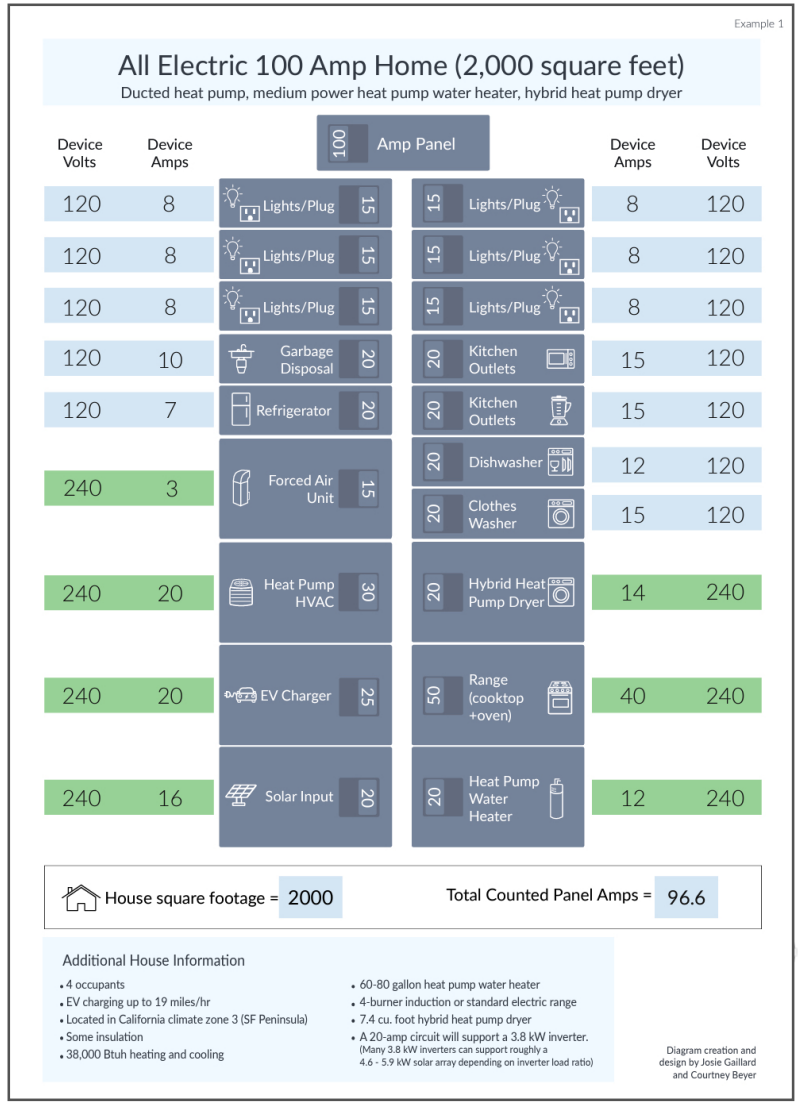
- Electric panel is full!
- Panel and service line need to be UPSIZED
- Utility gets involved
- Long wait times
- Could cost $5,000 (overhead service line) and $20,000 (underground)

Benefits of Electrifying WITH a Plan

- Helps avoid ~$5,000+ electric panel upgrade
- Provides roadmap for homeowner
- Helps guide tradespeople
- Helps avoid unnecessary work and costly mistakes
- Facilitates right sizing equipment (vs. oversizing)
- Home more likely to be power efficient and grid-friendly

Panel optimization works:

- If house is <3000 sq ft and located in mild climate, 100 Amp panel is usually sufficient
- **Caveat:** Homes with 60 Amp panels or smaller should upsize panel and service line



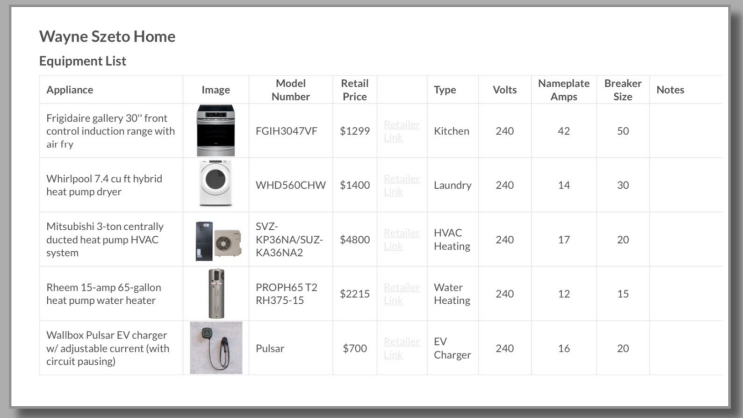
Components of an Electrification Plan

1. Recommended equipment list
2. Electrical load calculations per NEC 220.83(B) or 220.87
3. Project list for contractors with photos of existing equipment and locations
4. Wiring plan

Note:

- Homeowners can do their own or get help from an expert
- Plan takes expert ~30 minutes, homeowner ~3 hours

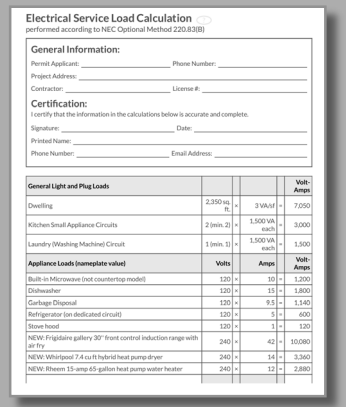
Electrification Plan



Wayne Szeto Home

Equipment List

Appliance	Image	Model Number	Retail Price		Type	Volts	Nameplate Amps	Breaker Size	Notes
Frigidaire gallery 30" front control induction range with air fry		FGIH3047VF	$1299	Retailer Link	Kitchen	240	42	50	
Whirlpool 7.4 cu ft hybrid heat pump dryer		WHD560CHW	$1400	Retailer Link	Laundry	240	14	30	
Mitsubishi 3-ton centrally ducted heat pump HVAC system		SVZ-KP36NA/SUZ-KA36NA2	$4800	Retailer Link	HVAC Heating	240	17	20	
Rheem 15-amp 65-gallon heat pump water heater		PROPH65 T2 RH375-15	$2215	Retailer Link	Water Heating	240	12	15	
Wallbox Pulsar EV charger w/ adjustable current (with circuit pausing)		Pulsar	$700	Retailer Link	EV Charger	240	16	20	



Electrical Service Load Calculation

performed according to NEC Optional Method 220.83(B)

General Information:

Permit Applicant: _____ Phone Number: _____

Project Address: _____

Contractor: _____ License #: _____

Certification:

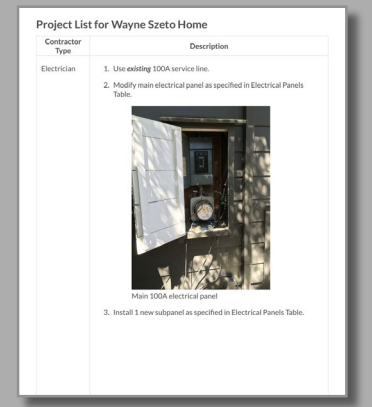
I certify that the information in the calculations below is accurate and complete.

Signature: _____ Date: _____

Printed Name: _____

Phone Number: _____ Email Address: _____

General Light and Plug Loads				Volt-Amps
Dwelling	2,350 sq. ft.	×	3 VA/sf	= 7,050
Kitchen Small Appliance Circuits	2 (min. 2)	×	1,500 VA each	= 3,000
Laundry (Washing Machine) Circuit	1 (min. 1)	×	1,500 VA each	= 1,500
Appliance Loads (nameplate value)	**Volts**		**Amps**	**Volt-Amps**
Built-in Microwave (not countertop model)	120	×	10	= 1,200
Dishwasher	120	×	15	= 1,800
Garbage Disposal	120	×	9.5	= 1,140
Refrigerator (on dedicated circuit)	120	×	5	= 600
Stove hood	120	×	1	= 120
NEW: Frigidaire gallery 30" front control induction range with air fry	240	×	42	= 10,080
NEW: Whirlpool 7.4 cu ft hybrid heat pump dryer	240	×	14	= 3,360
NEW: Rheem 15-amp 65-gallon heat pump water heater	240	×	12	= 2,880



Project List for Wayne Szeto Home

Contractor Type	Description
Electrician	1. Use existing 100A service line. 2. Modify main electrical panel as specified in Electrical Panels Table. Main 100A electrical panel 3. Install 1 new subpanel as specified in Electrical Panels Table.

Electrification Step 1

GATHER DATA

Data for electrification comes from 3 sources

1. Utility data showing home's current energy needs
    - Best to gather before home visit
2. Homeowner preferences
3. Home visit observations, measurements and photos

Utility Data

- Electricity usage history for home
  - Ideally 1 year of 15-minute interval data, but 60-minute is okay
  - Downloadable from utility using green button
- Gas usage history for home
  - Ideally 1 year of daily interval data
  - Downloadable from utility using green button

Homeowner Preferences

1. Which gas appliances to replace?
2. Do they want a home EV charger?
3. If they don't have solar/battery today, will they want it in the future?
4. Ideal location for new HVAC compressor?
5. Ideal location for new EV charger?
6. How many miles do you drive in a typical week?
7. On a cooktop, do they prefer buttons or knobs?
8. Could they live with a 4.3 cu ft (European-sized) dryer or do they need the typical 7.4 cu ft (American-sized) dryer?
9. Would they like a combo washer/dryer?
10. Happy with performance of current gas appliances or should adjustments be made in transition to electric?

Home Visit Data

- Observations, for example:
  - Shut-off breaker capacity on main panel
  - Open breaker spaces in main panel or subpanels
  - Size and location of all gas appliances
  - Nameplate ratings of all major electric appliances
- Measurements, for example:
  - Dimensions of spaces for new appliances
  - Dimensions of attic or crawlspace hatches, if contractors need access
  - Wire run lengths for new circuits (estimates okay)
  - Condensate line lengths for new HVAC and water heater

Home Visit Data: Stations

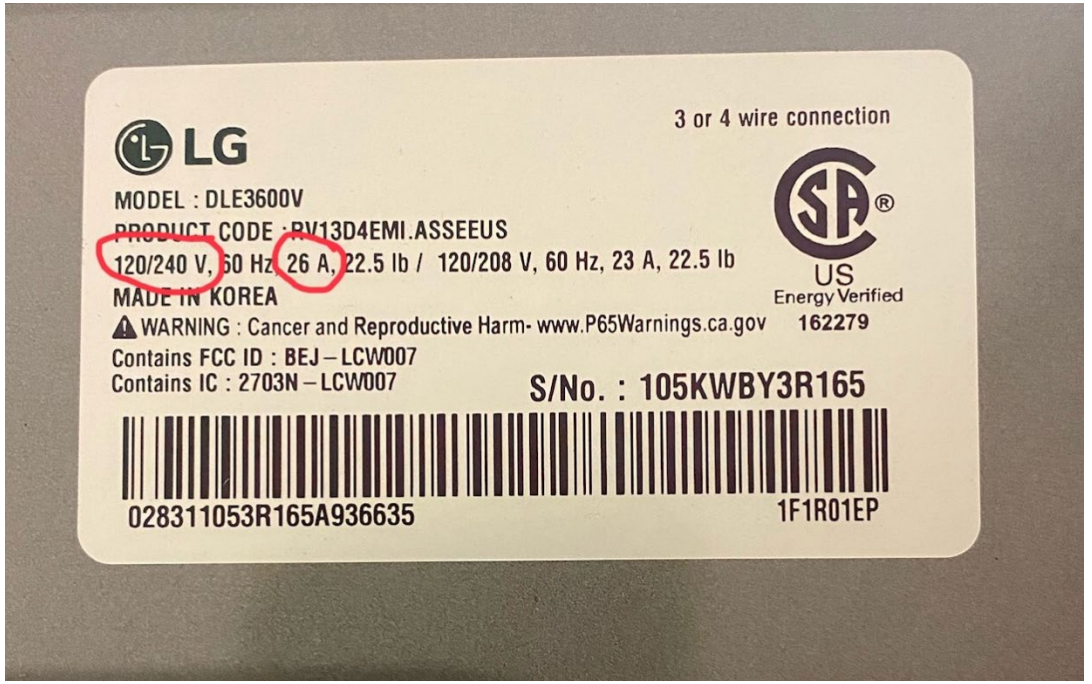
- Collect data in these groups/stations
  - Main panel & subpanels
  - Existing electric appliances
  - Each gas appliance to be replaced
    - Cooking
    - Water heater
    - Furnace
    - Clothes dryer
    - Other: fireplace, pool heater
  - EV charger location
  - Attic
  - Crawl space
  - Other: vents, ducts, wall insulation
  - Solar & Battery

Home Visit Data: Home, Main Panel & Subpanels

- Square footage of home
- Year home was built
- Shut-off breaker capacity of main panel
- Open breaker spaces in main panel and subpanels
- Busbar capacity of main panel and subpanels
- Feeder breaker capacity of subpanels

Home Visit Data: Existing Electric Appliances

- Find name plate for each major electric appliance:
  - Voltage
  - Amps
- Major appliances defined as:
  - Affixed to house or
  - Dedicated circuit
- Take a photo



Home Visit Data: Existing Electric Appliances

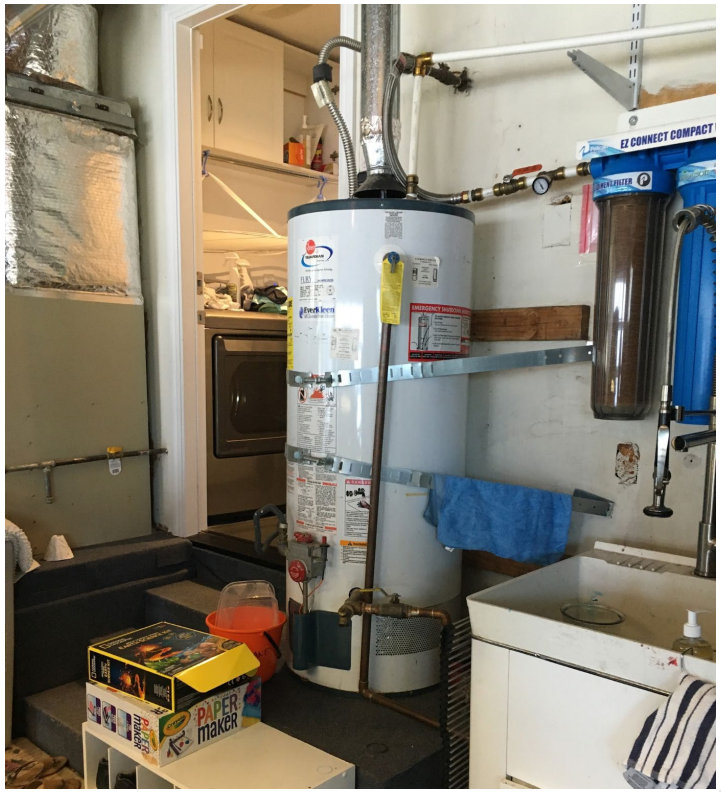
- Kitchen
  - Electric Range (single appliance with oven under cooktop)
  - Electric Cooktop
  - Electric Wall Oven
  - Stove Vent Hood
  - Built-in Microwave (not countertop model)
  - Refrigerator (on dedicated circuit)
  - Dishwasher
  - Garbage Disposal
  - Instant Hot Water Tap
  - Garbage Compactor
  - Extra Refrigerator or Freezer (standalone and on dedicated circuit)
- Laundry
  - Washing Machine
  - Electric Dryer
- Bathroom
  - Towel Warmer
- HVAC Heating
  - Heat Pump HVAC
  - Electric Baseboard Heating or Similar
  - Heated Floor
  - Bathroom Heater
- HVAC Air Conditioning
  - Central Air Conditioner
  - Window Mounted Air Conditioner
  - Whole House or Attic Fan
  - Evaporative Cooler
- Water Heating
  - Electric Resistance Tank Water Heater
  - Electric Resistance Tankless Water Heater
  - Heat Pump Water Heater
- Whirlpool Tub (in bathroom)
- Spa/Hot Tub (outdoors)
- Hot Water Circulation Pump
- Pool
  - Swimming Pool Main Pump
  - Swimming Pool Supplemental Pump
  - Swimming Pool Heater
- EV Charger
  - Level 1 Electric Vehicle Charger/Outlet
  - Level 2 Electric Vehicle Charger/Outlet
- Home Battery System

Home Visit Data: Gas Cooking

- Number of burners on cooktop
- Physical dimensions (width)
- Range type: free-standing vs. slide-in
- Number of oven cavities
- New circuit length and feeder panel
- Take a photo

Home Visit Data: Gas Water Heater

- Tank or tankless?
- Tank size
- Recirculating pump?
- Location
- Dimensions of physical space for water heater
- 400 cu ft space around it?
- Route for condensate drainage
- Water heater efficiency
- New circuit length and feeder panel
- Take a photo



Home Visit Data: Gas Furnace

- Type: ducted forced air, wall furnace, floor furnace
- Location
- Dimensions of physical space for heat pump air handler
- Route for condensate drainage
- Furnace efficiency
- Distance between furnace and preferred compressor location
- New circuit length and feeder panel
- Take a photo

Home Visit Data: Gas Clothes dryer

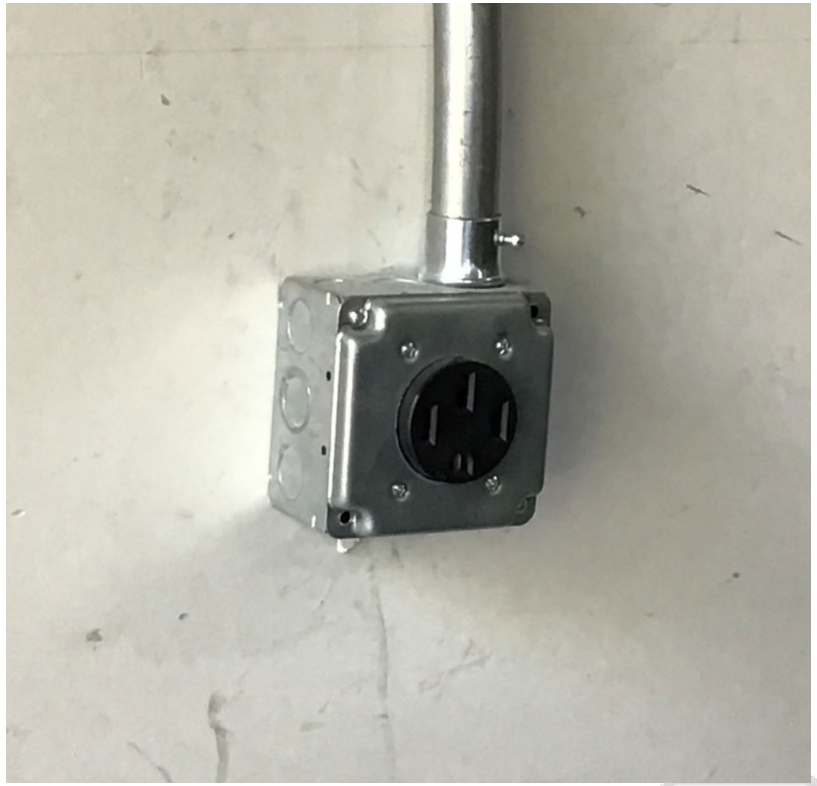
- Drum size
- Dimensions of physical space for dryer
- New circuit length and feeder panel
- Take a photo

Home Visit Data: Gas Fireplace & Pool Heater

- Dimensions of physical space for fireplace/pool heater
- Heating capacity of pool heater (BTUs/hr)
- New circuit length and feeder panel
- Take a photo

Home Visit Data: EV Charger

- Desired location
- New circuit length and feeder panel
- Take a photo



Home Visit Data: Attic & Crawl Space

- Condition & thickness of insulation
- Knob and tube wiring?
- Distance between joists
- Square feet of attic/crawl space
- Min/max height
- Access door dimensions
- Whether new circuits are best run through attic or crawl space
- Take photos

Home Visit Data: Vents, Ducts, Wall Insulation…

- Number of heating vents
- Number of duct air returns
- Vents in floor, ceiling or wall?
- Condition of ductwork
- Asbestos on ductwork?
- Ductwork diameter
- Walls insulated?
- Knob and tube wiring in walls?

Home Visit Data: Solar & Battery

- Roof material
- Any shade issues?
- Potential battery location
- Take photos

Data Gathering Now Complete

- Assuming no Manual J for HVAC, you have all the data you need for a plan
- Next step, crunching the numbers:
  - HVAC load calculations (today)
  - Electrical load calculations (8/29 class)
  - Equipment selection (8/29 class)
  - Wiring plan (9/5 class)
  - Project plan for contractors (9/5 class)

Methods for Calculating Home Heating Load

HEAT PUMP HVAC SIZING

Why size heat pumps?

- For comfort
- For energy savings and operating cost savings
- For quiet operation
- For capital cost savings
  - (right size it the first time)

Methods (from worst to best)

	Example Result	
1) Put in the same size as before		
(60,000 Btuh = 5 tons, **Yowza!!**)	5 tons	1 minute
2) Follow another region's Rule of Thumb		
(e.g. 0.25 tons per hundred square feet)	5 tons	1 minute
(e.g. 0.15 tons per hundred square feet)	4 tons	1 minute
3) Perform Manual J calculation		
For hypothetical family	3.3 tons	4-6 hours
4) Base it on real life peak day gas usage		
For this family	2.4 tons	15 minutes

Manual J Method

During site visit gather info on:

1. All wall lengths and heights
2. All window sizes and types
3. All door sizes and types
4. Floor area to ground (**note:** by type of space under floor)
5. Ceiling area (**note:** by type of space above ceiling)
6. Other features like chimney area to outside.
7. Air leakage estimate (in house air volume exchanges per hour [ACH])

Manual J: Materials

Gather info on the building materials for:

- Roof and attic
- Walls
- Windows
- Doors
- Floors to unconditioned space

- Pay attention to whether they are insulated and with how much insulation

Manual J: Assemblies

- **Find R-Value for each Assembly Component:**
  - Inside air film
  - Sheetrock
  - Vapor barrier (if present)
  - Air space or insulation R-Value
  - Sheathing material (plywood, OSB, diagonal boards etc.)
  - House wrap or building paper (if present)
  - Stucco or wood siding etc.
  - Exterior air film
- Add them up to find the total R-Value of the wall
- Invert the R Value to give U-Value of the wall

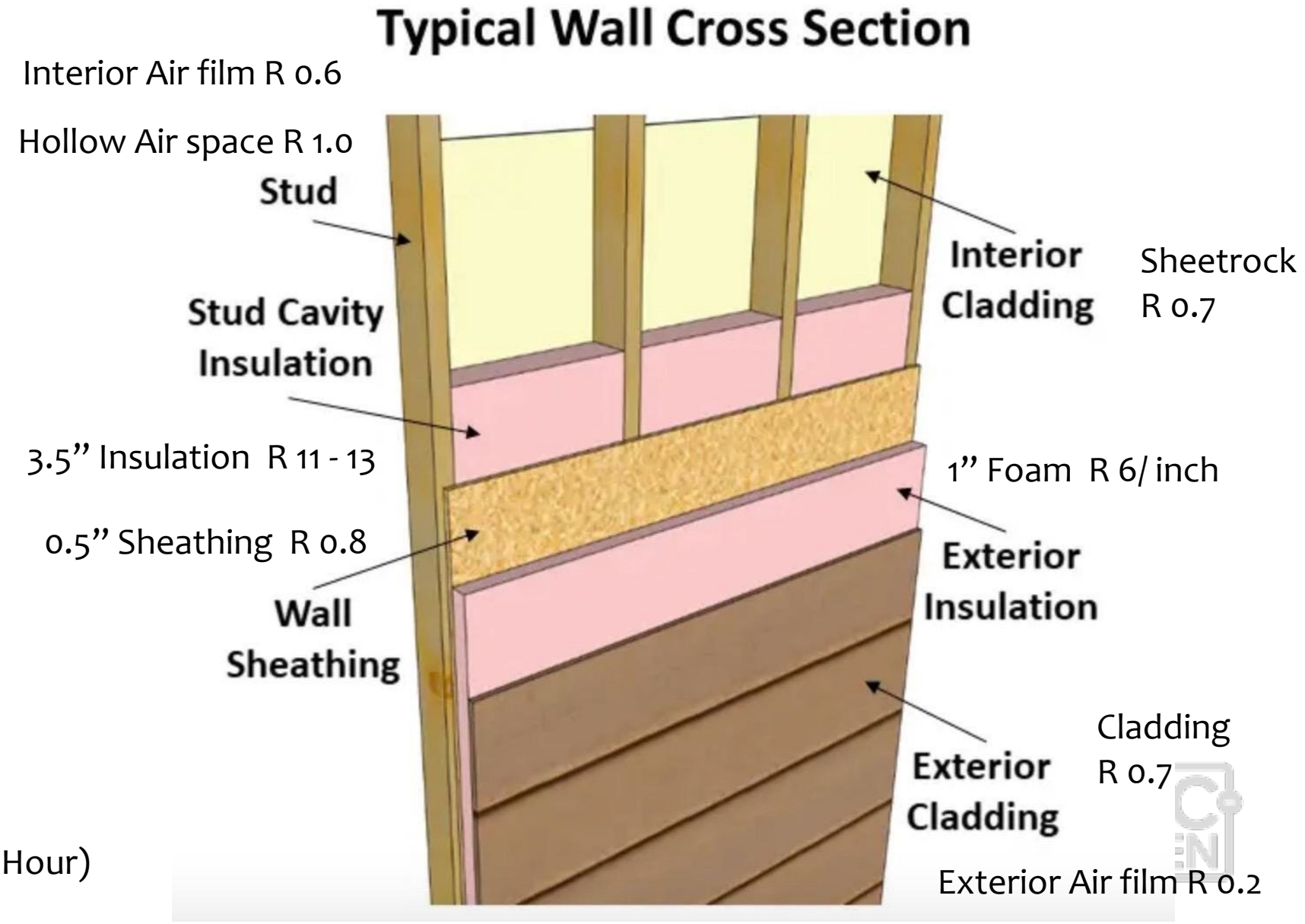
Assembly

Hollow		**Insulated**	
Int. Air Film	0.6	Int. Air Film	0.6
Sheetrock	0.7	Sheetrock	0.7
Airspace	1.0	Insulation	11.0
Sheathing	0.8	Sheathing	0.8
Cladding	0.7	Cladding	0.7
Ext Air film	0.2	Ext Air film	0.2

Total Hollow R 4.0 Insulated R 14.0

U Value 1/ 4 = 0.25 1/ 14 = 0.071

U= Btu / (Square Foot * Degree F * Hour)



Manual J: Assemblies

Repeat The Assembly R-Value Calculations for each Different situation:

- (Assembly type or exterior space type)
- Different type of wall
- And for the wall to the garage
- Repeat for each different type of ceiling
- Repeat for each different type of floor
- Repeat for each different type of unconditioned space under floor

Manual J: Assembly UAs

For every Assembly:

- Multiply the assembly area by its U-Value and by the design temperature difference (indoor temp minus outdoor temp)
- Use the buffered unconditioned space temperatures for the garage wall and for the floor over crawl space or basement etc. E.g. crawlspace = 50F design CA coast
- These give the rate of design heat loss through each assembly/outdoor space condition (Btu/ Hour @Design temperature)

Manual J Calculations

Sum the Design Heat Loss rates of all components

- All walls to exterior
- All ceilings to exterior
- All floors to exterior
- All windows (from conditioned space)
- All doors (from conditioned Space)
- **The total is the design heat loss rate of the surfaces**

Manual J: Air Infiltration

Make an estimate of the design air leakage rate.

- Typically:
  - 1 House volume per hour for a normal 2 story house (1 ACH)
  - 0.9 House volume per hour for a normal 1 story house
- Can use a blower door test and that may matter in severe climates

- Example result:
  - 1 ACH * 2,000 sqft floor * 8 foot wall height = 16,000 Cubic feet of air infiltration per hour
  - 16,000 * 0.18 Btu/cubic foot per degree F * (70F-30F) = 11,520 Btuh design infiltration loss

Manual J Calculations

Sum the design heat loss rates of surfaces and infiltration

Example:

All surfaces subtotal	22,000 Btuh	
Infiltration	11,520 Btuh	
Total for building	**33,520 Btuh**	
Ductwork ~20%	6,500 Btuh	
Total with ductwork	**40,000 Btuh**	**3.3 tons**
The culmination of a hundred estimates		

Alternative Method

HVAC Sizing Using Peak Day Gas Usage

Peak Day Gas Usage Method

Concept:

- Future peak days are similar to prior peak days for this family
- So determine how much gas heat was required on a prior peak day
- Then size the heat pump to be able to deliver that much heat in a reasonable number of hours

Peak Day Gas Usage Method

Method:

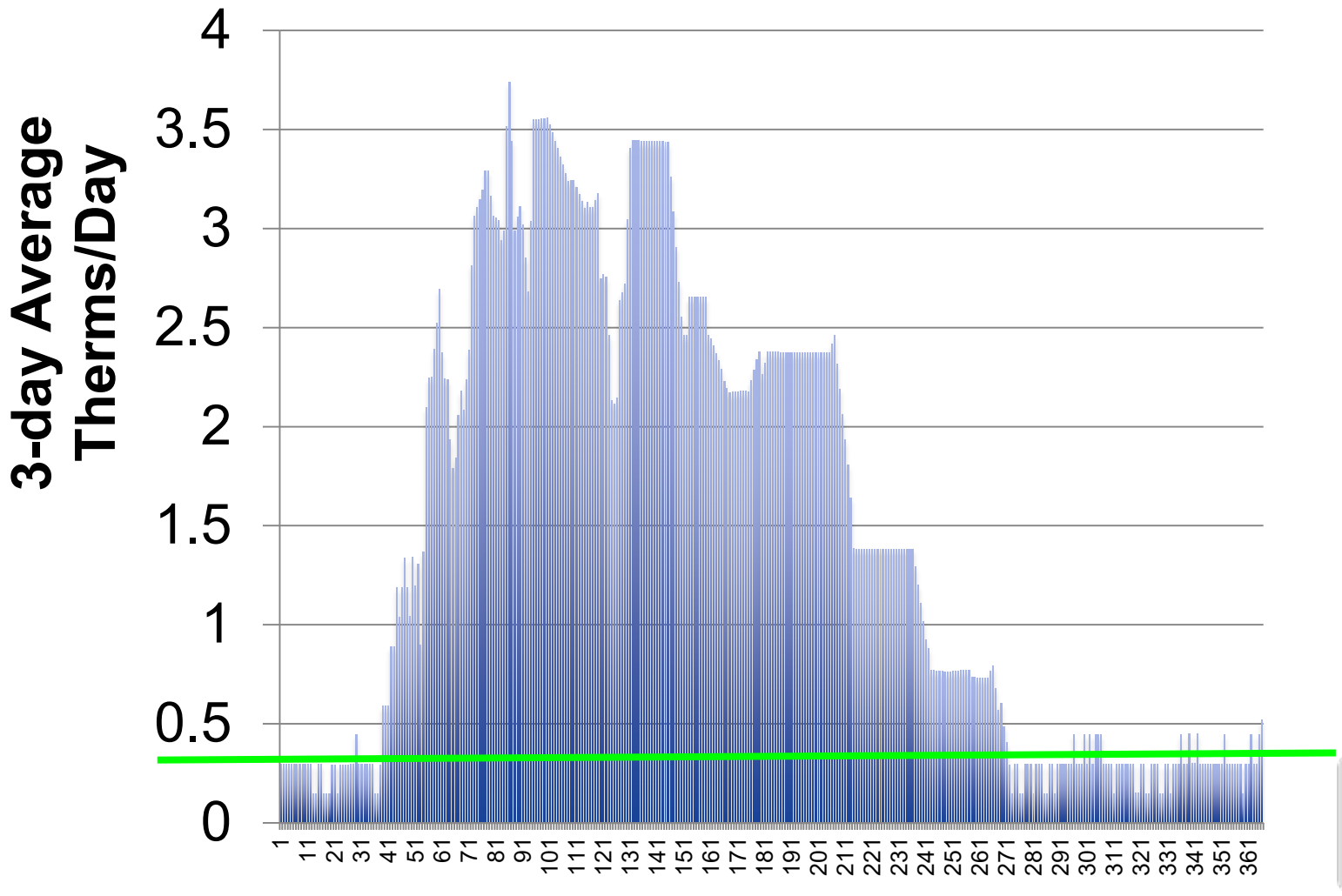
- Get utility smart meter data for daily gas use for the prior year
  - (365 numbers… gas therms used per day)
- Find Average daily gas use in summer months when family is home
  - e.g. 0.4 Therms/day
- Find peak gas use day in winter
  - e.g. 5.1 Therms of gas/ peak day

Actual Therm Use 3-Day Average

Looking at

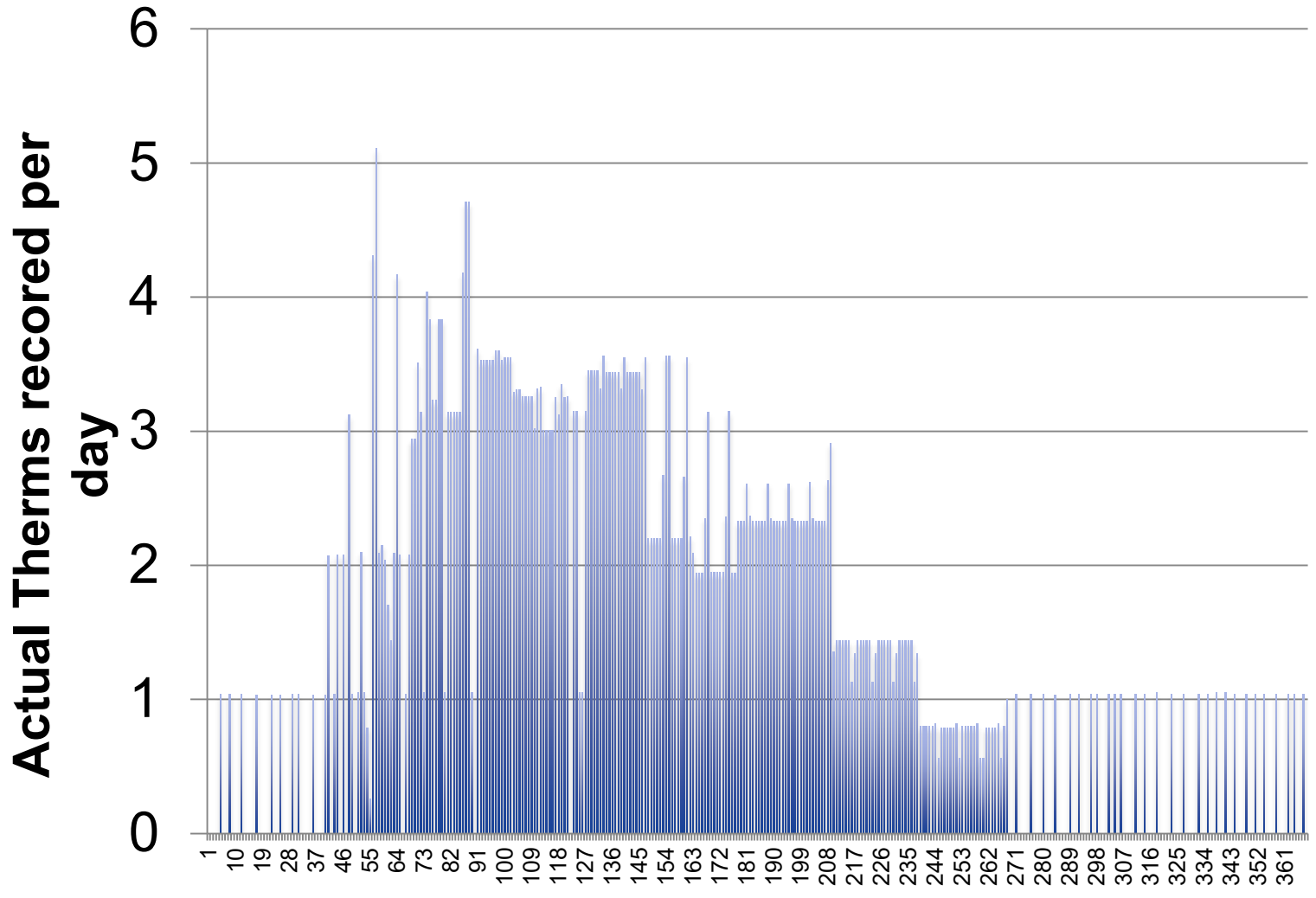
3-day rolling average

to find daily (summer) average of non-heat gas usage.



Actual Therm Use Recorded

For finding the peak day gas usage



Peak Day Gas Usage Method

Method Continued:

- Subtract the summer gas average daily usage (water heat and cooking, drying) from the winter peak day usage to see they needed: 5.1 minus 0.4 = 4.7 Therms of gas
  - 4.7 Therms of gas for heating on peak day
- If furnace nameplate indicates furnace is 80% efficient then 376,000 Btus of heat were delivered at the furnace bonnet
  - (4.7 TH * 0.8 Eff * 100,000 Btu/Therm

    = 376,000 Btu of heat/peak day)

Peak Day Gas Usage Method

Method:

- Convert to ton-hours of heating
- 376,000 Btu / 12,000 Btu/ton-hour

  = 31.3 ton hours of heat needed on peak day
- Tidbit: Gas furnace ran for 6.3 hours on peak day

  (376,000 BTU / 60,000 Btu/hr = 6.3 hours)

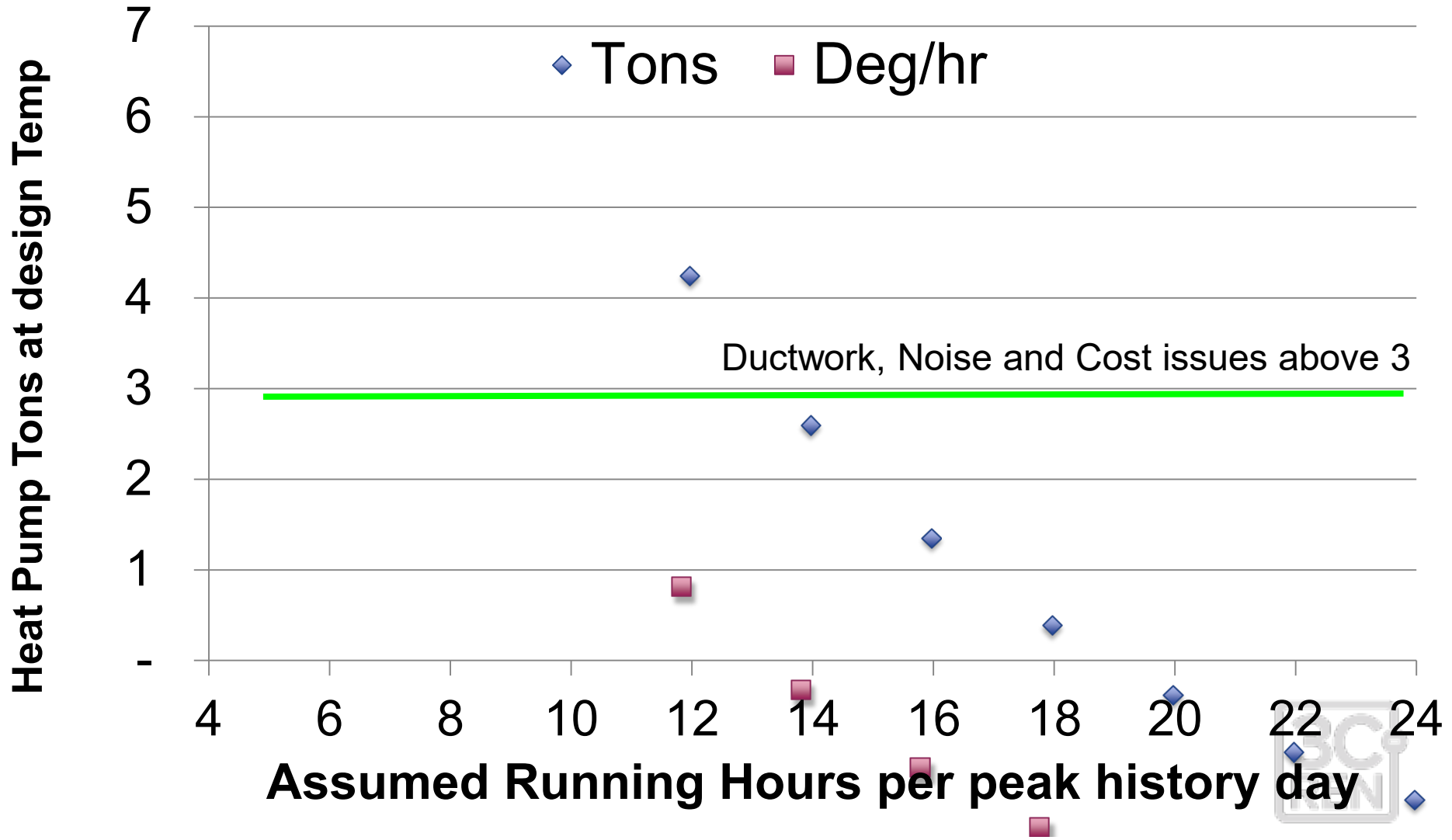
Peak Day Gas Usage Method

Method:

- Pick a heat pump size that can deliver the needed heat for the peak day
- 31.3 Ton-hours needed / 13 hours of full load operation on peak day = 2.4 tons needed to provide heat to the bonnet of ductwork
- 2.4 * (1- 20% duct heat loss and leakage) = 1.9 tons needed if it was ductless
- The culmination of reality & 4 assumptions (listed later)

Heat Pump size and outcomes

- Heat Pump Tons
  &
- Degree rise/ hour



Peak Day Gas Usage Method

The 4 assumptions we make:

1. That the peak day rounding error is small enough
2. That the future will similar to the recent past (can adjust)
3. That the nameplate, e.g. 80%, efficiency was right
4. That the heat pump will have about 13 hours to get the heating done in the peak day

The peak day gas usage method quickly gives real world answers.

- Operating adjustments can be made like running the unit longer on the peak day in real life
- An added insulation project can be separately evaluated as a single surface UA change (BTU saved on peak day) This lets you explore whether insulation and air sealing projects let you downsize the heat pump

Manual J Cons and Pros

Cons:

- Lots of data
- Lots of estimates and assumptions
- Lots of effort & attention

Pros:

- Can help explore the $ value of insulation projects and air sealing
- Can help explore room issues
- Can explore whether insulation and air sealing can let you downsize the heat pump

Time Comparison of Methods

	Manual J	Peak Day Gas Usage
Gathering data off site	10 min	10 min
Gathering data on site	60 min (x 2 people)	2 min
Entering data	60 min	1 min
Calculations	0-80 min	0-5 min
	Can give room info + ½ AC info (not crucial) May overlook something	
Total Minutes	130 – 210 (190-270) min	13 - 18 min
Best for	New House Plans	Retrofits

Questions?

Closing

- Coming to Your Inbox Soon!
  - Slides, Recording, & Survey – Please Take It and Help Us Out!
- Upcoming Courses:
  - Home Electrification Planning Class 2: Panel Optimization (8/29)
  - Home Electrification Planning Class 3: Developing and Electrification Plan (9/5)
  - Getting Past Heat Pump Objections (9/8)
  - Introduction to Passive House Retrofits (9/11)
  - Installing Heat Pumps: Lessons from the Field (9/13)

Links & Resources Mentioned

- Calculator for determining R-value of wood framed walls: https://www.builderscalculator.com/wall-r-value-calculator-for-wood-framed-walls/

- Electrification Planning Tool: www.zerocarbon-home.com

Thank you!

For more info:
3c-ren.org

For questions:
info@3c-ren.org

3C REN

TRI-COUNTY REGIONAL ENERGY NETWORK

SAN LUIS OBISPO • SANTA BARBARA • VENTURA