No-Nonsense Energy Analysis for HVAC

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National Comfort Institute, Inc.

NCI™ National Comfort Institute, Inc.

AHR EXPO ORLANDO • FEB 3-5 • 2020

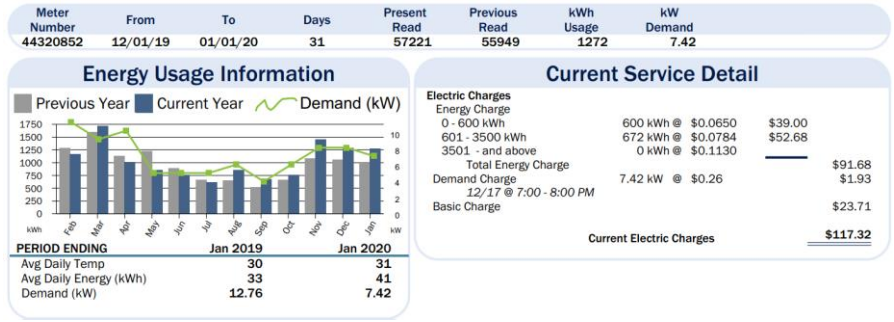
NATIONAL BALANCING COUNCIL™

Introduction

- We're often asked: How much will it save?
- It's a difficult question to answer
  - Every home is unique
  - Deemed savings don't work for individual homes
  - Other methods aren't quick, cheap, or simple
- A simple method to estimate savings and present them to homeowners in terms they understand

Outline

- The customer's first two questions
- The usual answer
- The better answer
- Performing a basic utility bill analysis
  - Gathering and cleaning the data
  - Choosing units: kWh, therms, or dollars
  - Estimating baseline HVAC energy use
  - Weather normalization
  - Estimating bill savings
- The conversation at the kitchen table
- Resources and tools
- Summary and Conclusion



Meter Number	From	To	Days	Present Read	Previous Read	kWh Usage	kW Demand
44320852	12/01/19	01/01/20	31	57221	55949	1272	7.42

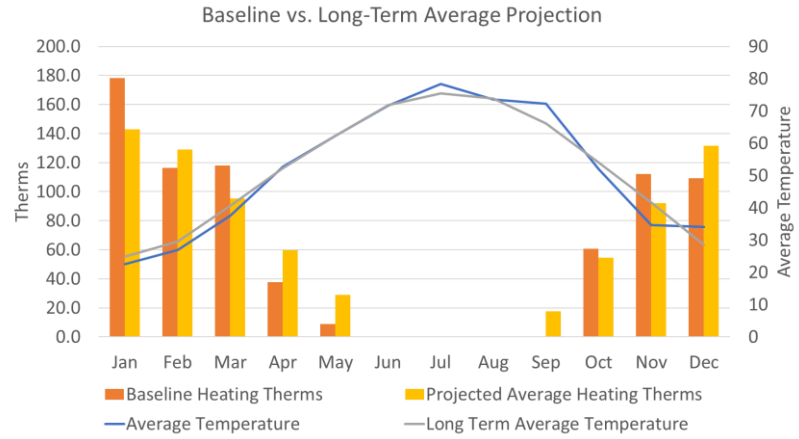
Energy Usage Information

Previous Year Current Year Demand (kW)

PERIOD ENDING	Jan 2019	Jan 2020
Avg Daily Temp	30	31
Avg Daily Energy (kWh)	33	41
Demand (kW)	12.76	7.42

Current Service Detail

Electric Charges			
Energy Charge			
0 - 600 kWh	600 kWh @	$0.0650	$39.00
601 - 3500 kWh	672 kWh @	$0.0784	$52.68
3501 - and above	0 kWh @	$0.1130	
Total Energy Charge			$91.68
Demand Charge	7.42 kW @	$0.26	$1.93
12/17 @ 7:00 - 8:00 PM			
Basic Charge			$23.71
Current Electric Charges			$117.32



The Customer's First Two Questions

HOW MUCH WILL IT COST?

HOW MUCH WILL IT SAVE?

The Usual Answer

Basic

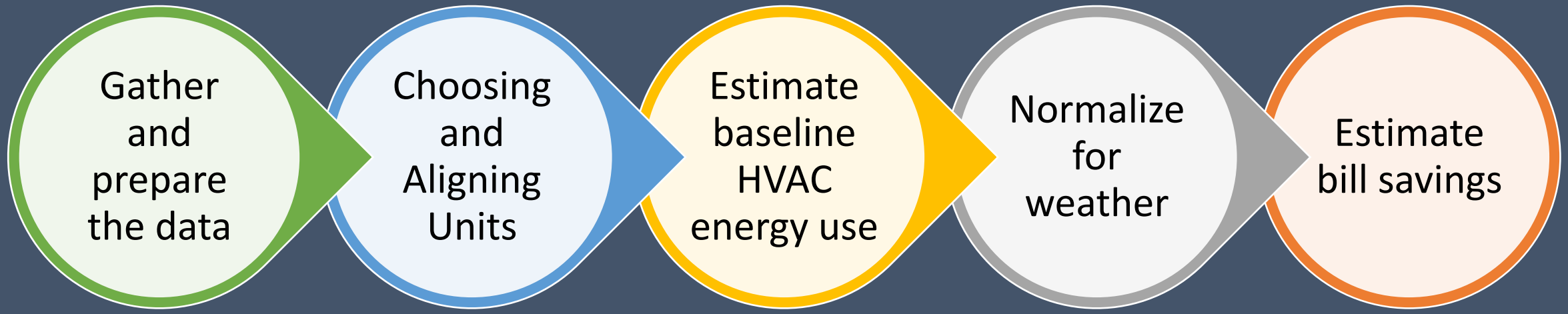
- $
- 13 SEER

Hi

ves 32%

Saves 32% of WHAT?

Energy Analysis Process Overview

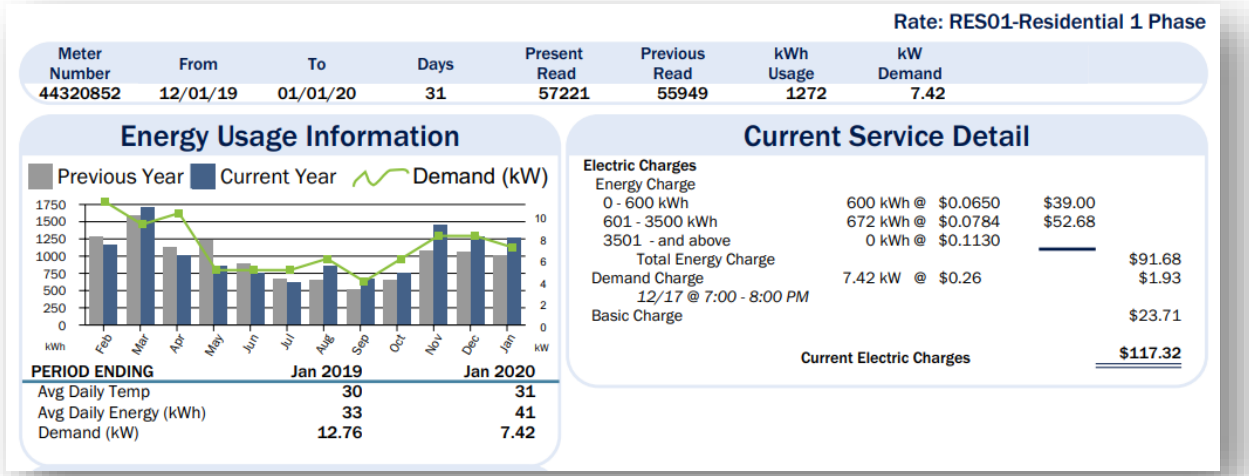



Gather and
prepare
the data

Gather and prepare the data

Energy Use and Cost Data Sources

Utility Bills



Rate: RES01-Residential 1 Phase

Meter Number	From	To	Days	Present Read	Previous Read	kWh Usage	kW Demand
44320852	12/01/19	01/01/20	31	57221	55949	1272	7.42

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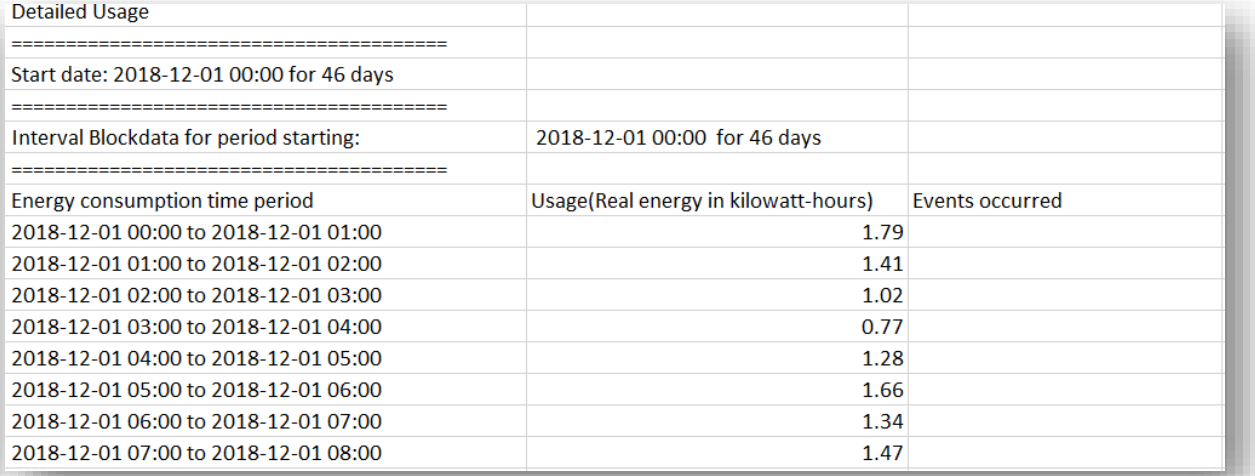
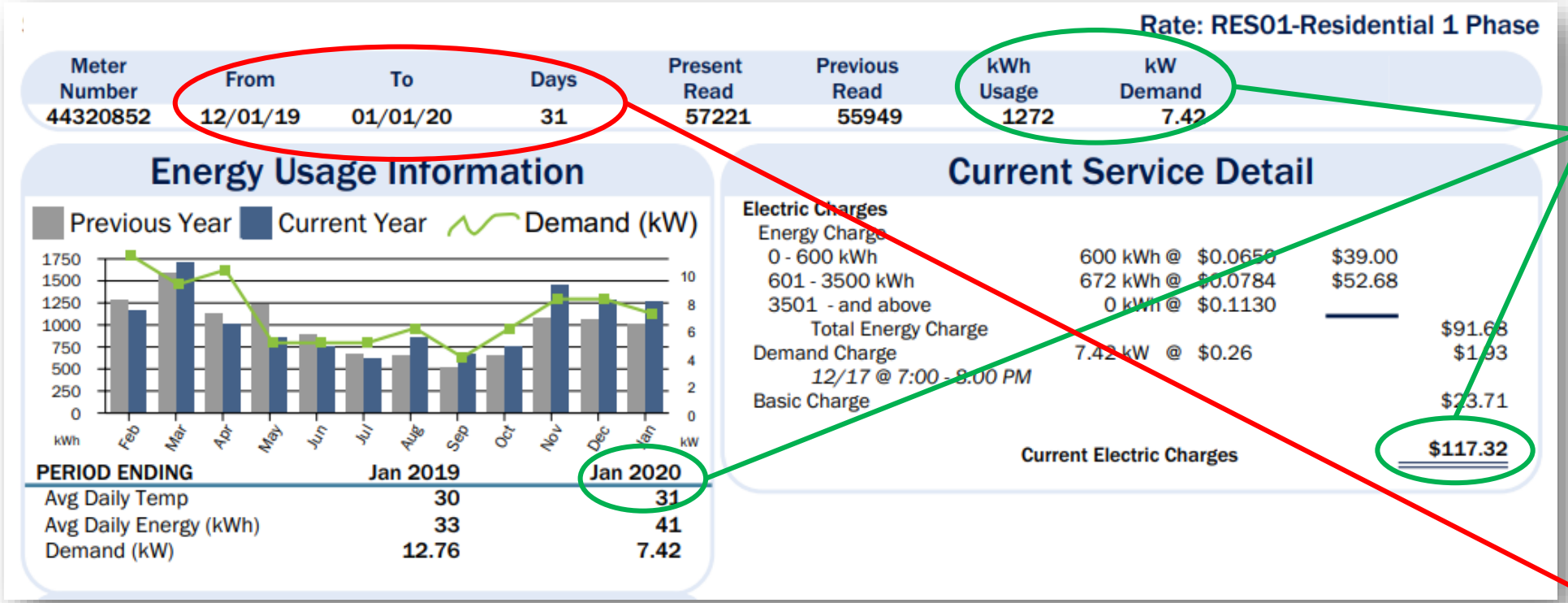
Download Data



Detailed Usage		
==========		
Start date: 2018-12-01 00:00 for 46 days		
==========		
Interval Blockdata for period starting:	2018-12-01 00:00 for 46 days	
==========		
Energy consumption time period	Usage(Real energy in kilowatt-hours)	Events occurred
2018-12-01 00:00 to 2018-12-01 01:00	1.79	
2018-12-01 01:00 to 2018-12-01 02:00	1.41	
2018-12-01 02:00 to 2018-12-01 03:00	1.02	
2018-12-01 03:00 to 2018-12-01 04:00	0.77	
2018-12-01 04:00 to 2018-12-01 05:00	1.28	
2018-12-01 05:00 to 2018-12-01 06:00	1.66	
2018-12-01 06:00 to 2018-12-01 07:00	1.34	
2018-12-01 07:00 to 2018-12-01 08:00	1.47	

Gather and prepare the data

Utility Bills



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Pros

- Customers might have on file
- Includes many types of data incl. energy use, costs, peak demand, average daily temp

Cons

- Manual data entry for analysis
- Billing periods may be inconsistent

Gather and prepare the data

Download Data

==========	
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==========	
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2018-12-01 06:00 to 2018-12-01 07:00	1.34
2018-12-01 07:00 to 2018-12-01 08:00	

Data for period starting: 2018-10-03 00:00Â for 1 day		
Energy consumption time period	**Usage (Real energy (Watt-hours))**	**Events occurred**
2018-10-03 00:00Â to 2018-10-04 00:00Â	56000	Â

Data for period starting: 2018-10-04 00:00Â for 1 day		
Energy consumption time period	**Usage (Real energy (Watt-hours))**	**Events occurred**
2018-10-04 00:00Â to 2018-10-05 00:00Â	40000	Â

Pros

- No manual data entry
- Custom time periods
- Custom data intervals

Cons

- More granular data means more analysis steps
- May not have cost, temperature, or demand data
- Format may require additional data manipulation
- Customer may not want or be able to get data

Gather and prepare the data

Select Data

- Select most recent 12-month period with close to 30 days in each bill, in a period of “normal” use
- Use current charges for cost rather than amount due
- Use actual meter reads, avoid estimated when possible
- Avoid data with gaps or overlaps

Date Mailed	Billing Period	Billed Days	Total Therms	Current Charges	Total Amount Due
04/02/2019	03/25/19 - 03/30/19	5	1	$2.03	$1.38
03/27/2019	02/22/19 - 03/25/19	31	47	$60.35	$35.35
02/26/2019	01/23/19 - 02/22/19	30	68	$88.25	$23.25
01/25/2019	12/21/18 - 01/23/19	33	72	$96.47	$63.07
12/26/2018	11/21/18 - 12/21/18	30	47	$58.55	$86.60
11/26/2018	10/22/18 - 11/21/18	30	28	$33.25	$28.05
10/24/2018	09/19/18 - 10/22/18	33	19	$25.04	$5.20 CR
09/21/2018	08/21/18 - 09/19/18	29	15	$21.81	$47.76
08/23/2018	07/20/18 - 08/21/18	32	17	$25.95	$25.95
07/24/2018	06/20/18 - 07/20/18	30	15	$20.41	$19.83
06/22/2018	05/21/18 - 06/20/18	30	17	$22.10	$45.42
05/23/2018	04/20/18 - 05/21/18	31	20	$23.32	$23.32
04/24/2018	03/22/18 - 04/20/18	29	22	$24.77	$69.29
03/26/2018	02/21/18 - 03/22/18	29	41	$44.52	$44.52
02/23/2018	01/20/18 - 02/21/18	32	48	$52.98	$52.98
01/23/2018	12/19/17 - 01/20/18	32	56	$60.54	$44.78
12/21/2017	11/20/17 - 12/19/17	29	37	$41.19	$40.24
11/22/2017	10/18/17 - 11/20/17	33	23	$27.60	$27.05

Gather and prepare the data

Preparing Utility Bill Data

1. Assign each bill to a month for analysis
   - Assign to the month that most of the billed days fell on

   -OR-
   - Calculate average daily use for each billing period and use weighted average to assign calendar months
2. Number sequentially and sort so months are in order starting in January

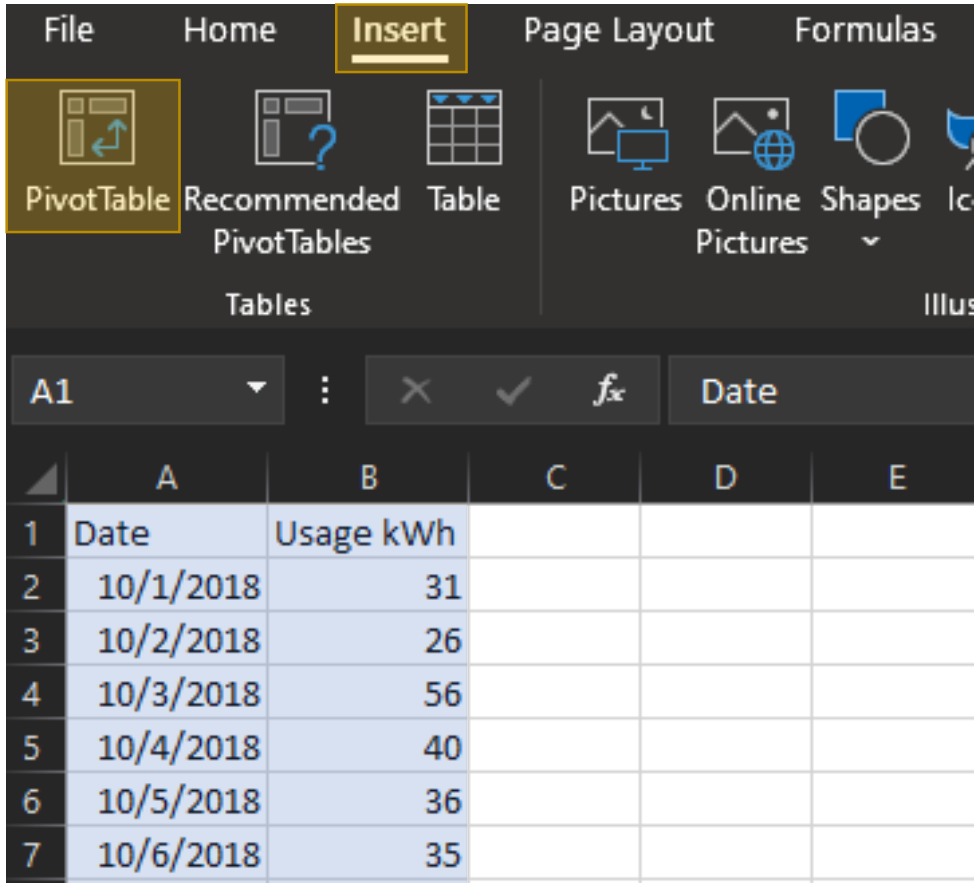
Date Mailed	Billing Period Start	Billing Period End	Billed Days	Total Therms	Current Charges	Month	Month #
1/25/2019	12/21/2018	1/23/2019	33	72	$96.47	Jan	1
2/26/2019	1/23/2019	2/22/2019	30	68	$88.25	Feb	2
3/27/2019	2/22/2019	3/25/2019	31	47	$60.35	Mar	3
4/24/2018	3/22/2018	4/20/2018	29	22	$24.47	Apr	4
5/23/2018	4/20/2018	5/21/2018	31	20	$23.32	May	5
6/22/2018	5/21/2018	6/20/2018	30	17	$22.10	Jun	6
7/24/2018	6/20/2018	7/20/2018	30	15	$20.41	Jul	7
8/23/2018	7/20/2018	8/21/2018	32	17	$25.95	Aug	8
9/21/2019	8/21/2018	9/19/2018	29	15	$21.81	Sep	9
10/24/2018	9/19/2018	10/22/2018	33	19	$25.04	Oct	10
11/26/2018	10/22/2018	11/21/2018	30	28	$33.25	Nov	11
12/26/2018	11/21/2018	12/21/2018	30	47	$58.55	Dec	12

Gather and prepare the data

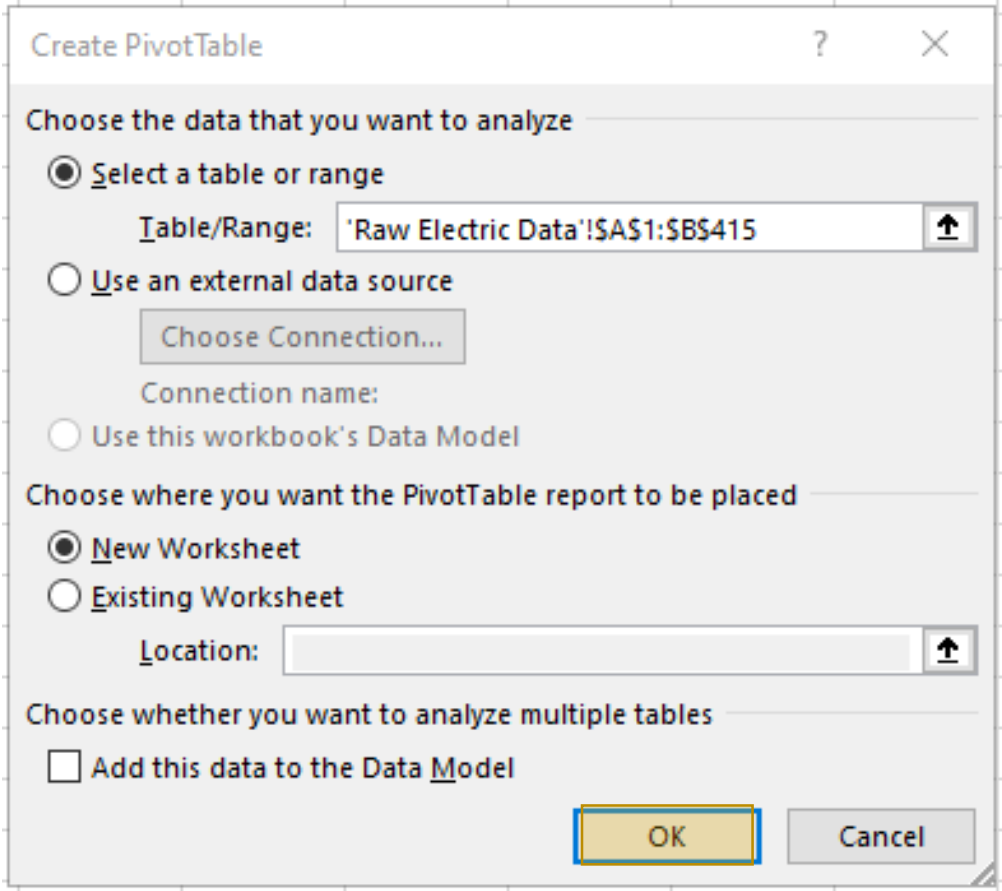
Preparing Downloaded Data – Roll up to Monthly

Date	Usage kWh
10/1/2018	31
10/2/2018	26
10/3/2018	56
10/4/2018	40
10/5/2018	36
10/6/2018	35
10/7/2018	32
10/8/2018	63
10/9/2018	18
10/10/2018	13
10/11/2018	13
10/12/2018	13
10/13/2018	14
10/14/2018	12
10/15/2018	14

Daily Utility Data .csv



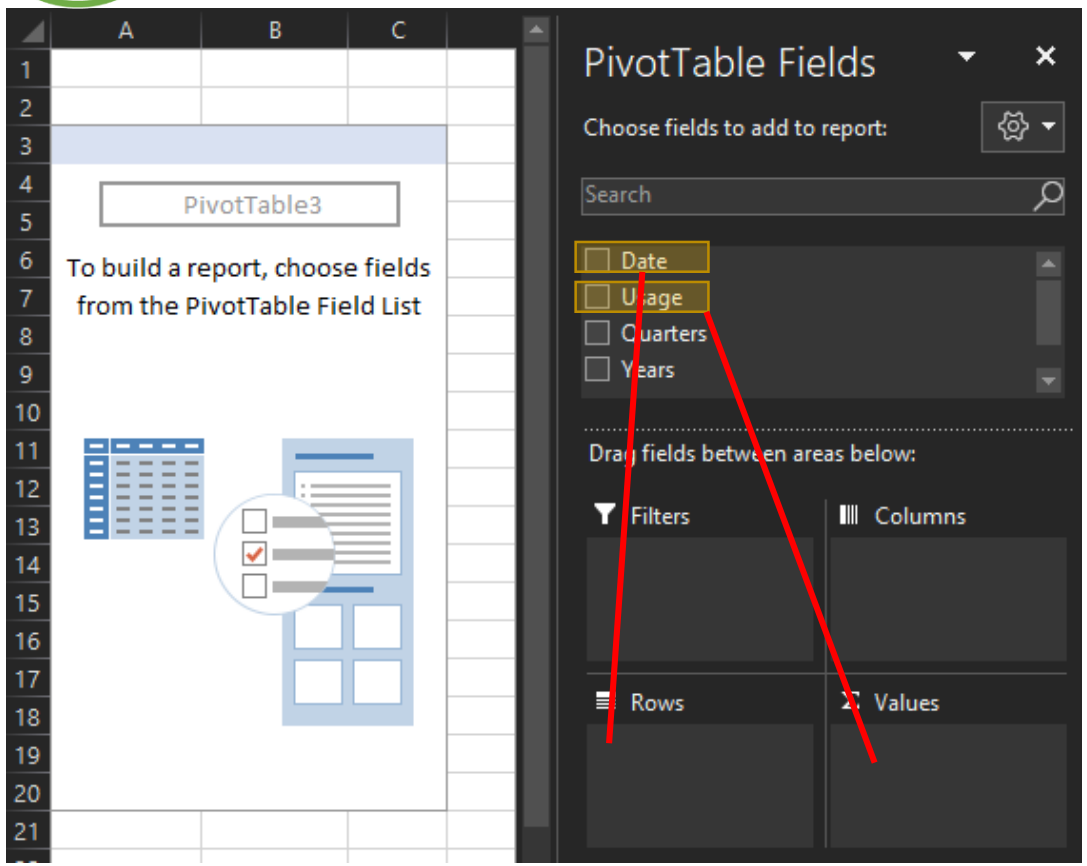
1. Select all data
2. Insert > PivotTable



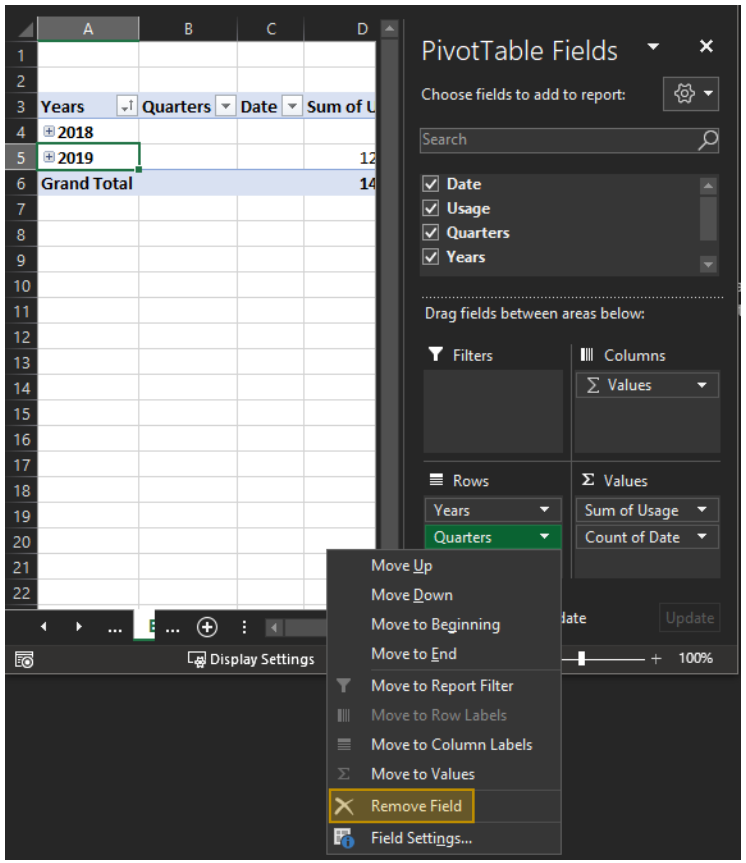
3. Click OK

Gather and prepare the data

Preparing Downloaded Data - Continued



4. Drag Date field to Rows
5. Drag Usage field to Values
6. Drag Date field to Values



7. Remove Quarters

Row Labels	Sum of Usage	Count of Date
2018		
Oct	642	31
Nov	749	30
Dec	724	31
2019		
Jan	796	31
Feb	466.64	27
Mar	888.98	31
Apr	604.38	30
May	1061.56	31
Jun	1154.19	30
Jul	2017.14	31
Aug	2031.98	31
Sep	1521.24	30
Oct	954.24	31
Nov	719.35	19
Grand Total	**14330.7**	**414**

8. Hit + on years to expand to months
9. Select 12 most recent complete months

Choosing and Aligning Units

Choosing and Aligning Units

- Customers think in terms of dollars, not kWh and Therms
- Different rate structures mean it's not a straight conversion between energy use and cost
- Best to pull in data for gas and electric use *and* cost, we can use them all in the analysis
- Analyze cooling and heating bills separately, convert and combine energy and costs at the end
- For heat pumps, make an educated guess about which months are predominantly heating or cooling, and separate them

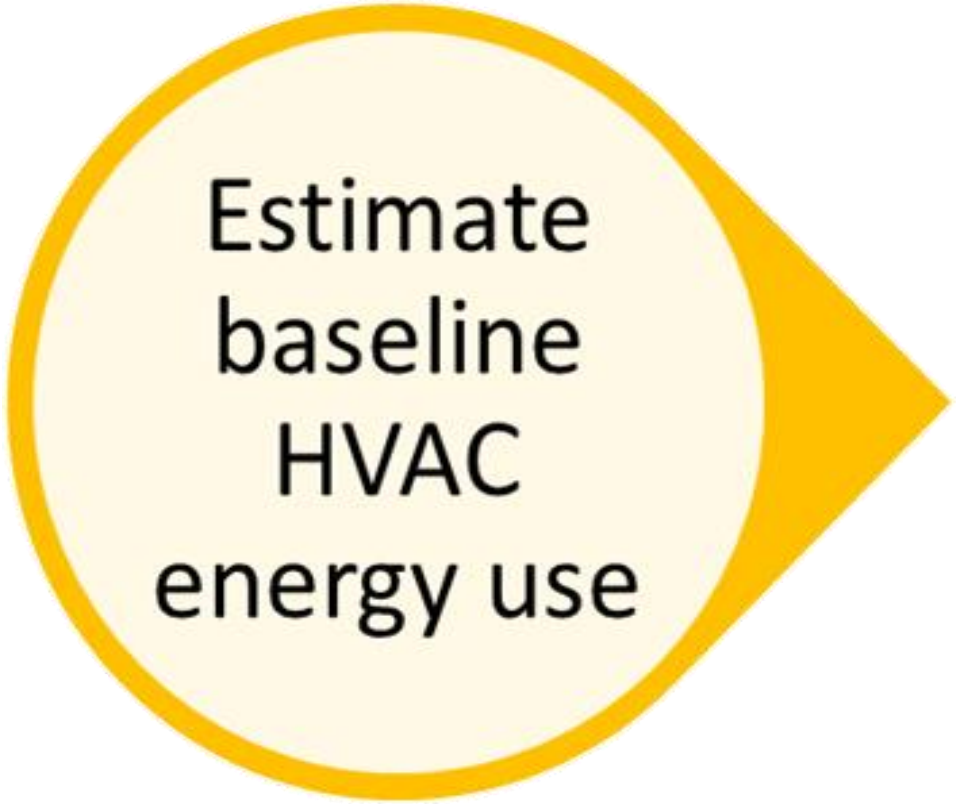
kWh

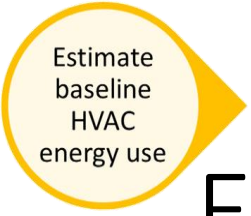
Therms

$

Example House

- Located in Peoria, IL
- 3,210 square feet
- Built in 2009
- Two gas furnaces, 167 kBTUh output total, both 92 AFUE
- Two AC units, 7 tons total, both 15 SEER
- Electric and Gas from Ameren


Estimate
baseline
HVAC
energy use



Estimating Heating and Cooling Costs

1. Estimate “Base Load”
   - Non-heating gas loads – water heating, clothes drying, cooking
   - Non-heating or cooling electric loads – lighting, water heating, clothes washing and drying, cooking, refrigeration, plug loads, etc.
2. Subtract Base Load from Bills

Estimate baseline HVAC energy use

Estimating Heating Use – Example

1. Average the 3 months with the lowest use
   - this is the estimated base load use
2. Subtract the average base load from the monthly use, zero out any negative values
   - this is the estimated monthly heating use
3. Total the monthly heating use for an estimate of the annual baseload and heating use

Month	Therms	Gas Bill	Baseload Therms	Heating Therms
Jan	190.0	$125.81	11.7	178.3
Feb	128.0	$88.83	11.7	116.3
Mar	129.8	$88.93	11.7	118.1
Apr	49.2	$40.30	11.7	37.5
May	20.5	$20.52	11.7	8.8
Jun	12.1	$17.35	11.7	0.4
Jul	11.9	$21.21	11.7	0.2
Aug	11.7	$21.40	11.7	0.0
Sep	11.6	$19.93	11.7	0.0
Oct	72.4	$65.58	11.7	60.7
Nov	124.0	$82.71	11.7	112.3
Dec	121.0	$85.14	11.7	109.3
	882.1	**$677.73**	**140**	**742**

Estimate baseline HVAC energy use

Estimate Heating Cost – Example Continued

1. Divide monthly bill by total monthly use to get average monthly $/Therm
2. Multiply average $/Therm by heating use to estimate heating costs
3. Total monthly costs for annual estimated costs

Month	Therms	Gas Bill	Heating Therms	Monthly $/Therm	Gas Heating Cost
Jan	190.0	$125.81	178.3	$0.66	$118
Feb	128.0	$88.83	116.3	$0.69	$81
Mar	129.8	$88.93	118.1	$0.69	$81
Apr	49.2	$40.30	37.5	$0.82	$31
May	20.5	$20.52	8.8	$1.00	$9
Jun	12.1	$17.35	0.4	$1.44	$1
Jul	11.9	$21.21	0.2	$1.79	$0
Aug	11.7	$21.40	0.0	$1.83	$0
Sep	11.6	$19.93	0.0	$1.72	$0
Oct	72.4	$65.58	60.7	$0.91	$55
Nov	124.0	$82.71	112.3	$0.67	$75
Dec	121.0	$85.14	109.3	$0.70	$77
	882.1	**$677.73**	**742**	**$0.768**	**$527**

Estimate baseline HVAC energy use

Monthly Electric and Gas Use and Cost

Month	Baseload kWh	Cooling kWh	Monthly $/kWh	Electric Baseload Cost	Electric Cooling Cost	Baseload Therms	Heating Therms	Monthly $/Therm	Gas Baseload Cost	Gas Heating Cost
Jan	598	198	$0.099	$60	$20	11.7	178.3	$0.66	$8	$118
Feb	598	0	$0.108	$65	$0	11.7	116.3	$0.69	$8	$81
Mar	598	291	$0.093	$55	$27	11.7	118.1	$0.69	$8	$81
Apr	598	6	$0.101	$61	$1	11.7	37.5	$0.82	$10	$31
May	598	463	$0.130	$78	$60	11.7	8.8	$1.00	$12	$9
Jun	598	556	$0.182	$109	$101	11.7	0.4	$1.44	$17	$1
Jul	598	1419	$0.083	$50	$118	11.7	0.2	$1.79	$21	$0
Aug	598	1434	$0.053	$32	$76	11.7	0.0	$1.83	$21	$0
Sep	598	923	$0.058	$35	$54	11.7	0.0	$1.72	$20	$0
Oct	598	356	$0.061	$36	$22	11.7	60.7	$0.91	$11	$55
Nov	598	151	$0.101	$60	$15	11.7	112.3	$0.67	$8	$75
Dec	598	126	$0.099	$59	$12	11.7	109.3	$0.70	$8	$77
Total or Average	**7180**	**5921**	**$0.092**	**$699**	**$506**	**140**	**742**	**$0.768**	**$151**	**$527**

Estimate baseline HVAC energy use

Using Baseline Data

- Now we're armed with estimated heating and cooling costs based on real data, but proceed with caution
  - Varying rates mean % energy savings don't directly translate to $ savings
  - An abnormally cold or warm year could skew results
- Use results to pre-qualify in a follow-up phone call:
  - "Based on preliminary analysis of your bills, your heating and cooling cost you over $1,000 in the past year…
  - As a rough estimate, our high efficiency option could save you about 40%, or $400 per year…
  - If you're truly interested, I can run some more numbers and give you a more precise estimate of the savings"


Normalize
for
weather

Normalize for weather

Normalizing for Weather

- So far, our analysis is based on last year's heating and cooling data, which are strongly influenced by last year's weather
- Last year's weather may or may not be similar to next year's weather, or to long term averages
- This can be used directly for savings estimates, but be cautious about how you present them: "This is what the new high efficiency system would have saved you in the past year"
- Normalization allows you to:
  - Project savings for a typical weather year
  - Compare utility bills before and after an upgrade to estimate savings

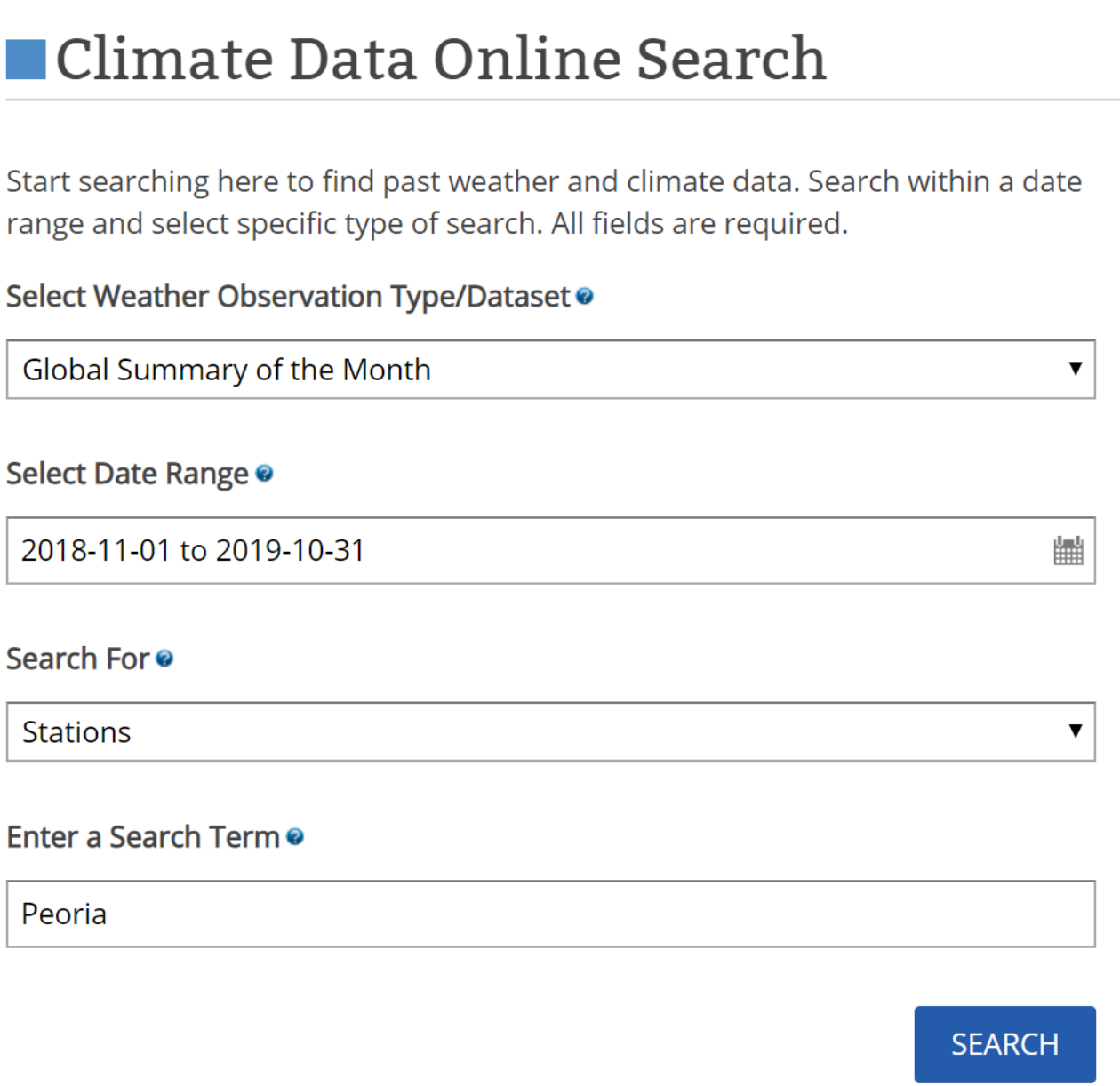
Do I Need to Normalize?

- For initial estimation purposes, normalization can often be skipped
- Consider whether the past year has had fairly typical weather, or if it's been out of the ordinary
- For a more scientific approach, compare the average temperatures for the billing period vs. long-term averages – if within a few degrees, consider skipping normalization
- We'll go through the normalization process quickly, but we don't have a lot of time to spend on the details
- Be sure to sign in with your email for a copy of the presentation

Normalize for weather

Obtain Weather Data

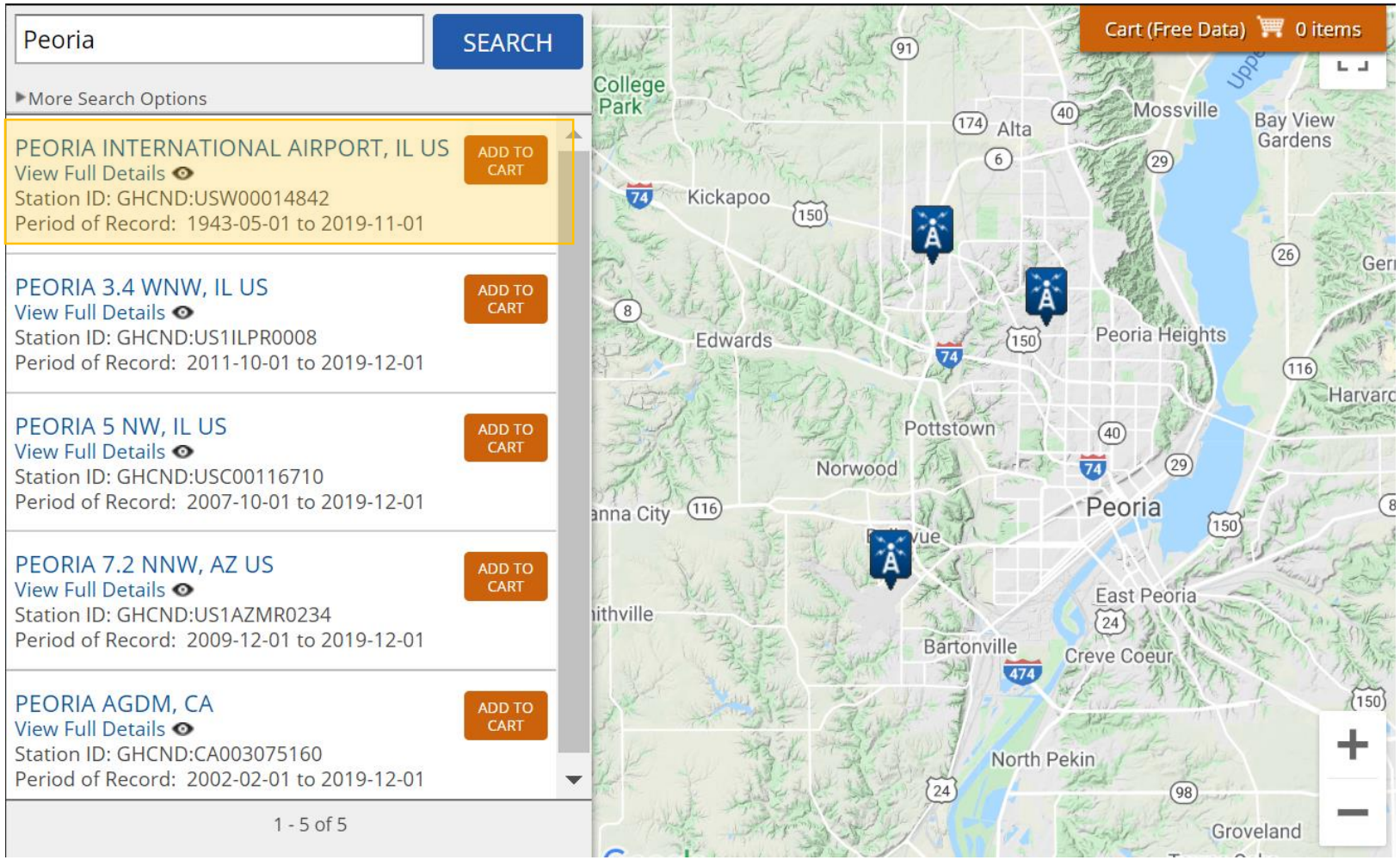
- Many data sources, we'll use NOAA Climate Data Online https://www.ncdc.noaa.gov/cdo-web/search
- Global Summary of the Month
- Date Range aligned with bills
- Search For: Stations, Zip Codes, Cities, etc.



Normalize for weather

Select a Weather Station

- Airports usually have the most reliable data
- Add to Cart



Normalize for weather

Home > Climate Data Online > Station Details

Datasets | Search Tool | Mapping Tool | Data Tools | Help

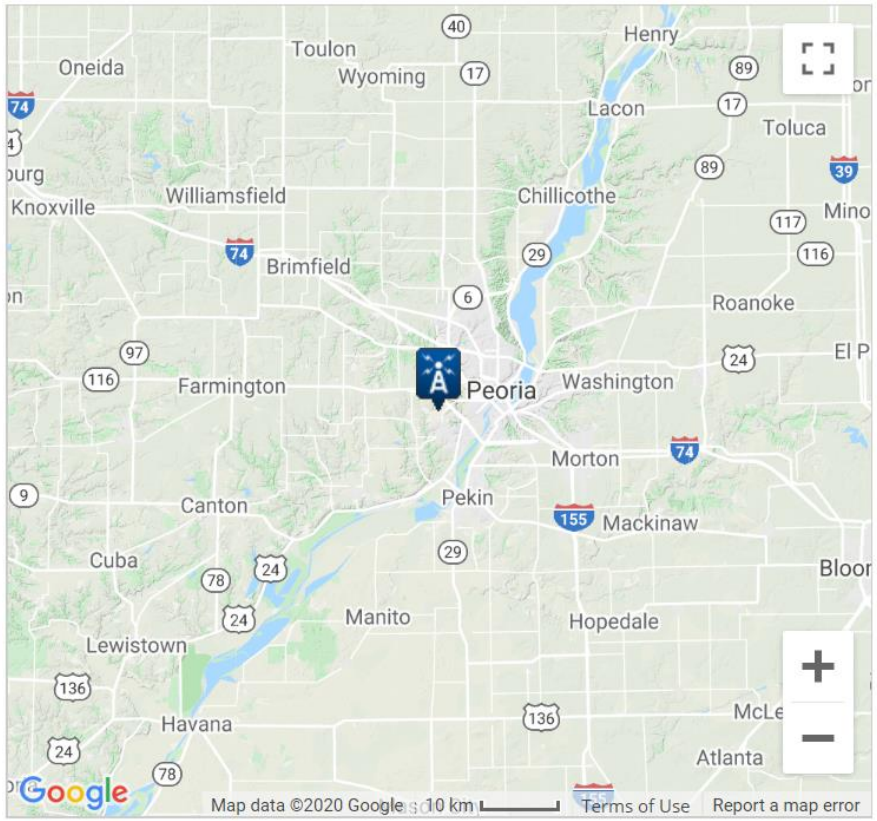
Cart (Free Data) 1 item

Global Summary of the Month Station Details

STATION DETAILS	
Name	PEORIA INTERNATIONAL AIRPORT, IL US
Network:ID	GHCND:USW00014842
Latitude/Longitude	40.6675°, -89.6839°
Elevation	198.1 m

PERIOD OF RECORD	
Start Date[1]	1943-05-01
End Date[1]	2019-11-01
Data Coverage[2]	100%

ADD TO CART



Step 1: Choose Options | Step 2: Review Order | Step 3: Order Complete

Select Cart Options

Specify the desired formatting options for the data added in the cart. These options allow more refined date selection, selection of the processed format, and the option to remove items from the cart.

Select the Output Format

Choose one option below to choose a type of format for download. Formats are a standard PDF format. Other formats are CSV (Comma Separated Value) and Text format, both of which can be opened with programs such as Microsoft Excel or OpenOffice Calc. Some formats have additional options which can be selected on the next page.

- ○ **Global Summary of The Month PDF**
  DOC Certification Option
  (Does not include all elements)
  - ☐ **Include Documentation**
- ◉ **Custom Global Summary of The Month CSV**
  (Additional options available on next page)

Select the Date Range

Click to choose the date range below.

2018-11-01 to 2019-10-31

Review the items in your cart

[CLEAR CART]

PEORIA INTERNATIONAL AIRPORT, IL US
View Full Details
Station ID: GHCND:USW00014842
Period of Record: 1943-05-01 : 2019-11-01
Delete

CONTINUE

Step 1: Choose Options | Step 2: Review Order | Step 3: Order Complete

Data types are grouped by category for easier selection and can be selected as a group or individually. Selected data types will be included in the customized output.

Station Detail & Data Flag Options

Additional output options such as data flags (attributes), station names, and geographic location are also available.

- ☑ Station Name
- ☐ Geographic Location
- ☐ Include Data Flags

Units Standard ▼

Select data types for custom output

The items below are data types that can be added to the output. Expand the data type category headers to view the categorized data type names and descriptions.

Show All / Hide All | Select All / Deselect All

- ☐ ⊞ Computed
- ☐ ⊞ Precipitation
- ☐ ⊟ Air Temperature
  - ☑ Average Temperature. (TAVG)
  - ☐ Cooling Degree Days Season to Date (CDSD)
  - ☐ Extreme maximum temperature for the period. (EMXT)
  - ☐ Extreme minimum temperature for the period. (EMNT)
  - ☐ Heating Degree Days Season to Date (HDSD)
  - ☐ Maximum temperature (TMAX)
  - ☐ Minimum temperature (TMIN)
- ☐ ⊞ Wind

BACK CONTINUE

Step 1: Choose Options | Step 2: Review Order | Step 3: Order Complete

Please review these selected items from your request: dataset, date ranges, output format, data types, and selected stations/locations.

Once your order is checked, enter a valid email address and click the "SUBMIT ORDER" button to finalize the order. No actual data will be emailed directly. Only the links to access your ordered data from an FTP site will be sent.

By submitting this request, you agree with both the disclaimer and the privacy policy.

REQUESTED DATA REVIEW	
Dataset	Global Summary of the Month
Order Start Date	2018-11-01 00:00
Order End Date	2019-10-31 23:59
Output Format	Custom Global Summary of The Month CSV
Data Types	TAVG
Custom Flag(s)	Station Name
Units	Standard
Stations/Locations	PEORIA INTERNATIONAL AIRPORT, IL US (Station ID: GHCND:USW00014842)

Enter email address

Please enter your email address. This is the address to which your data links and information regarding this order will be sent. Please read NOAA's Privacy Policy if you have any concerns.

Email Address
benl@ncihvac.com

Verify Email Address
benl@ncihvac.com

☑ **Remember my email address**
[Uncheck to forget]

NOAA will not share your email address with anyone. The email address will not be used for any purpose other than communicating the order status.

EDIT ORDER SUBMIT ORDER

Normalize for weather

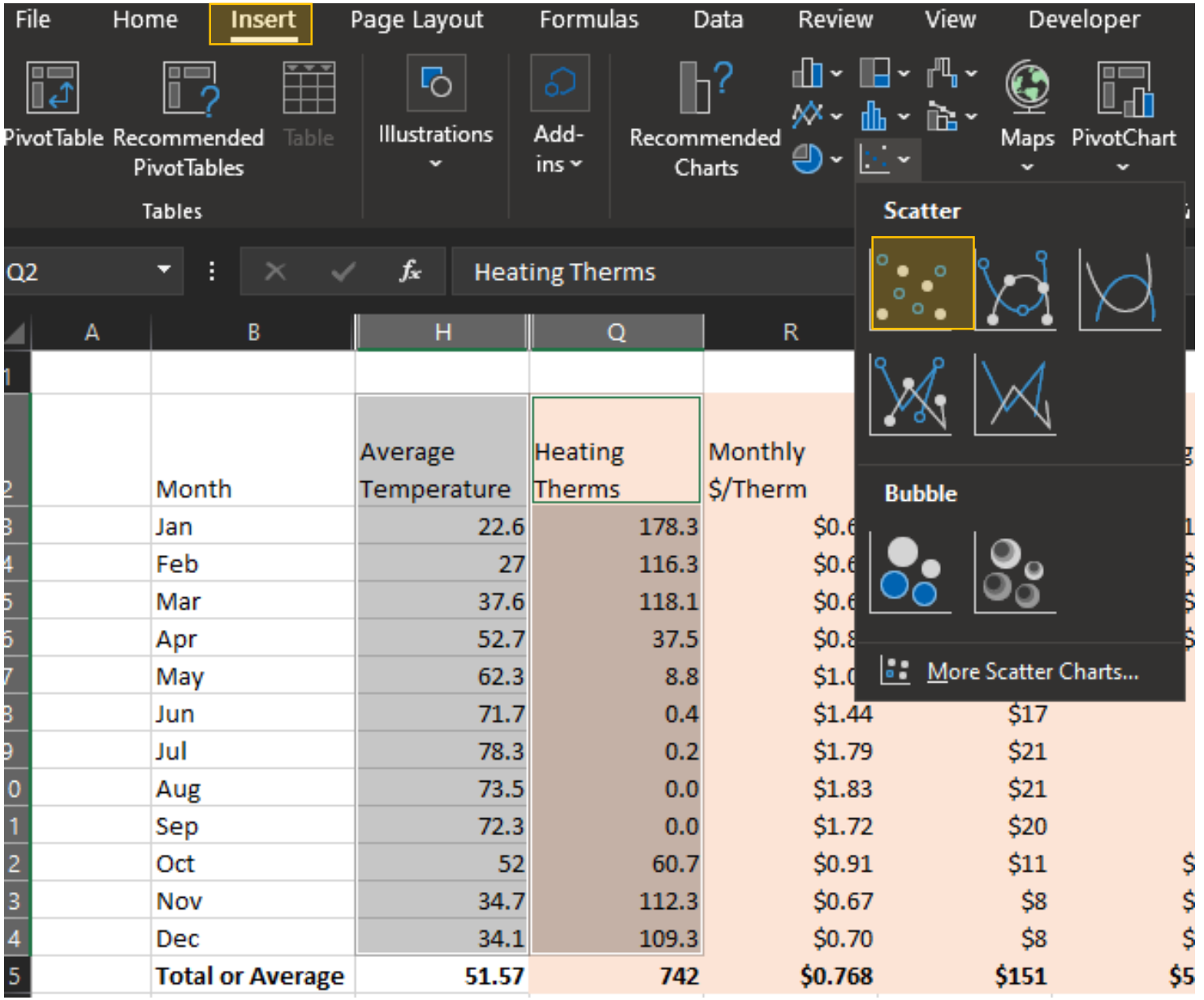
1. Order Confirmation Email, wait a minute or two
2. Order Complete Email, click Download
3. Copy and Paste the Average Temperature data aligned with utility bills in your analysis

STATION	NAME	DATE	TAVG
USW00014842	PEORIA INTERNATIONAL AIRPORT, IL US	2018-11	34.7
USW00014842	PEORIA INTERNATIONAL AIRPORT, IL US	2018-12	34.1
USW00014842	PEORIA INTERNATIONAL AIRPORT, IL US	2019-01	22.6
USW00014842	PEORIA INTERNATIONAL AIRPORT, IL US	2019-02	27
USW00014842	PEORIA INTERNATIONAL AIRPORT, IL US	2019-03	37.6
USW00014842	PEORIA INTERNATIONAL AIRPORT, IL US	2019-04	52.7
USW00014842	PEORIA INTERNATIONAL AIRPORT, IL US	2019-05	62.3
USW00014842	PEORIA INTERNATIONAL AIRPORT, IL US	2019-06	71.7
USW00014842	PEORIA INTERNATIONAL AIRPORT, IL US	2019-07	78.3
USW00014842	PEORIA INTERNATIONAL AIRPORT, IL US	2019-08	73.5
USW00014842	PEORIA INTERNATIONAL AIRPORT, IL US	2019-09	72.3
USW00014842	PEORIA INTERNATIONAL AIRPORT, IL US	2019-10	52

Normalize for weather

Plot Energy Use vs. Temperature

1. Select monthly Average Temperature and Heating Therms (or Cooling kWh)
2. Insert > Scatter Plot

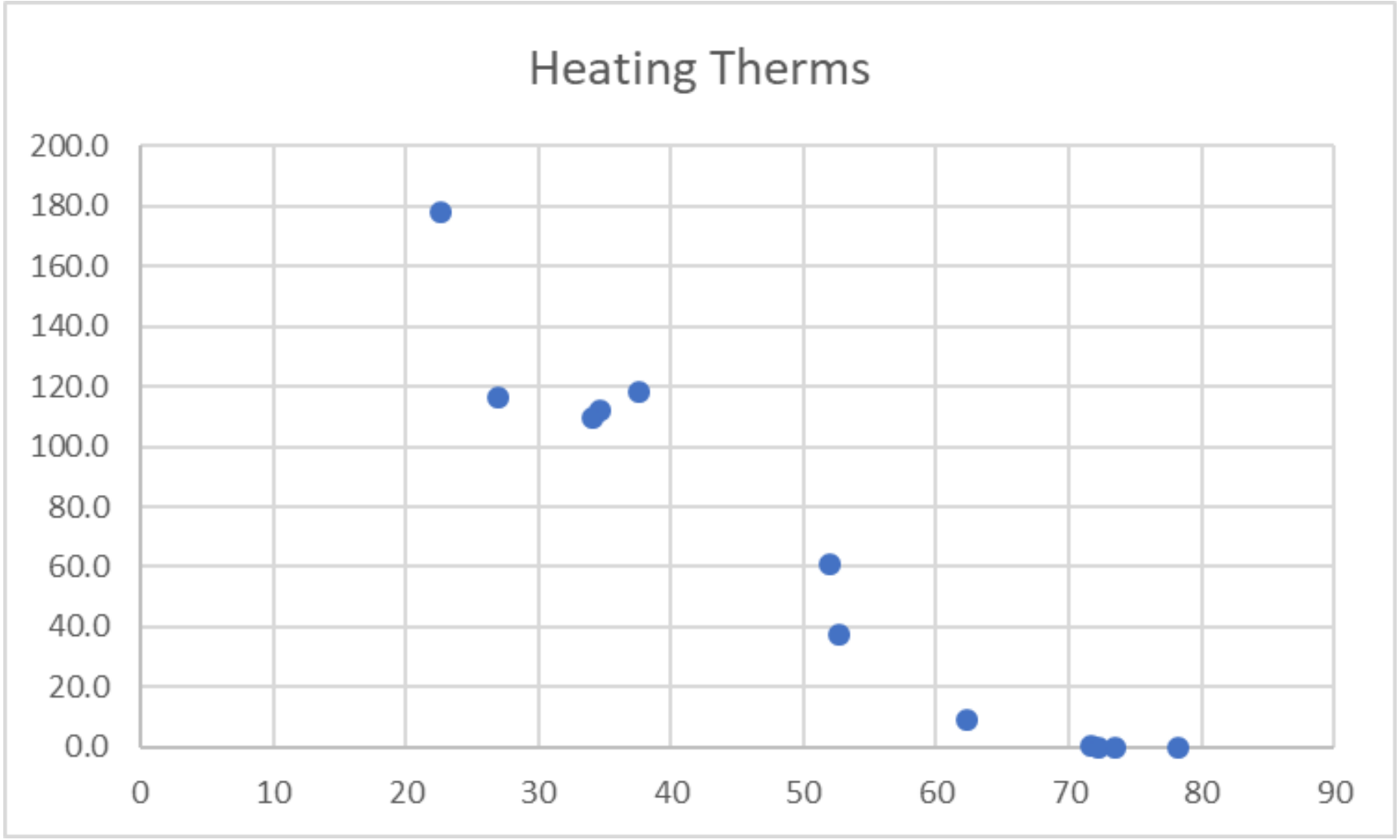


	A	B	H	Q	R
1					
2		Month	Average Temperature	Heating Therms	Monthly $/Therm
3		Jan	22.6	178.3	$0.6
4		Feb	27	116.3	$0.6
5		Mar	37.6	118.1	$0.6
6		Apr	52.7	37.5	$0.8
7		May	62.3	8.8	$1.0
8		Jun	71.7	0.4	$1.44
9		Jul	78.3	0.2	$1.79
10		Aug	73.5	0.0	$1.83
11		Sep	72.3	0.0	$1.72
12		Oct	52	60.7	$0.91
13		Nov	34.7	112.3	$0.67
14		Dec	34.1	109.3	$0.70
15		**Total or Average**	**51.57**	**742**	**$0.768**

Normalize for weather

Scatter Plot

Monthly Therms

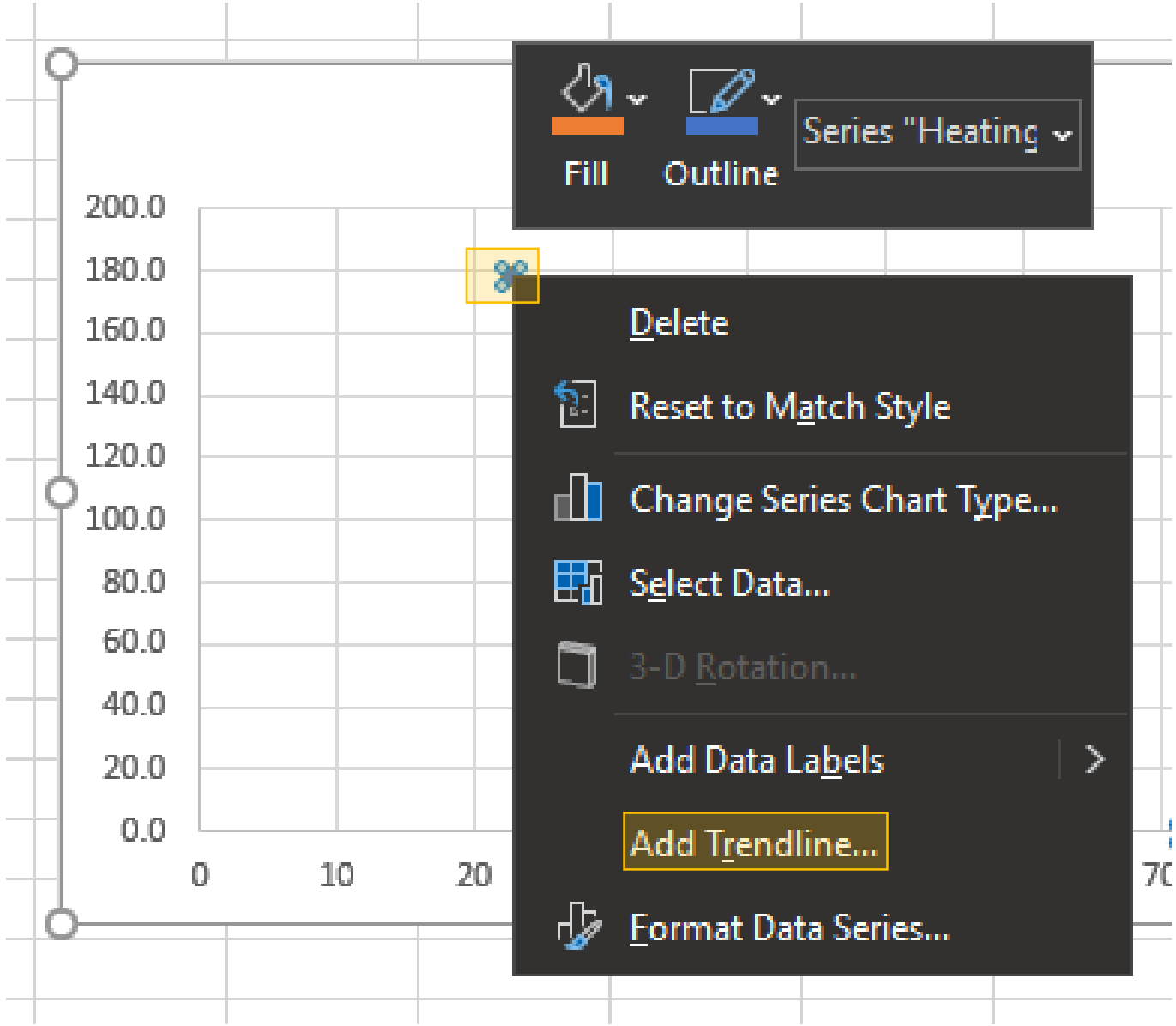


Average Monthly Temperature

Normalize for weather

Add a Trendline

- Right Click on a data point
- Add Trendline…

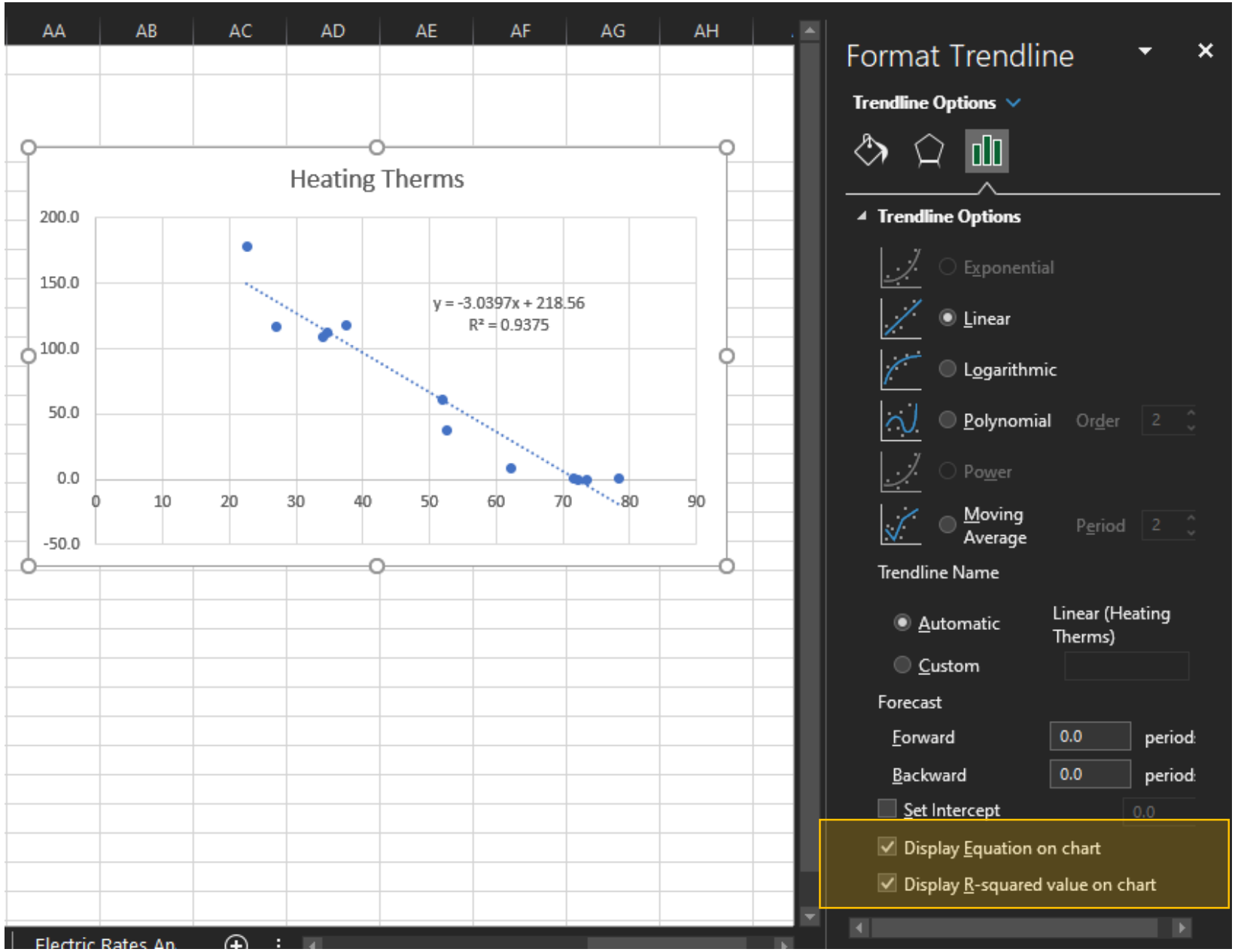


Normalize for weather

Get Trendline Equation

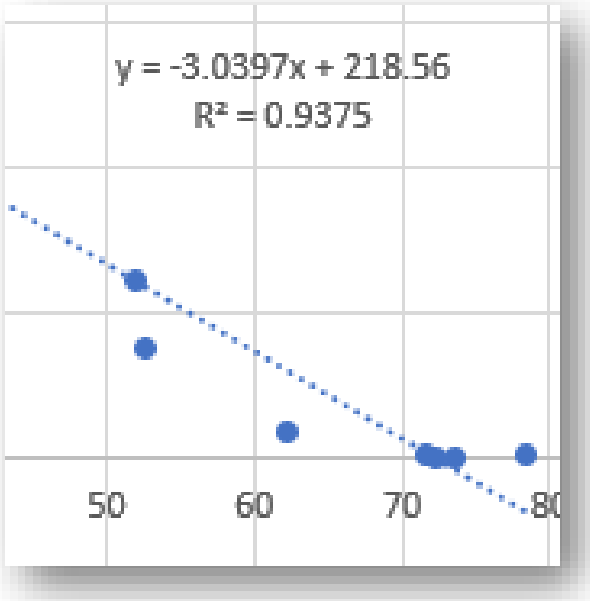
- Select Linear to start
- Display Equation on chart
- Display R-squared value on chart – the closer to 1 the better
- Copy equation

y = -3.0397x +218.56



Normalize for weather

Trendline Equation Breakdown



y = -3.0397x +218.56

Monthly Therms = -3.0397 * Monthly Average Temperature + 218.56

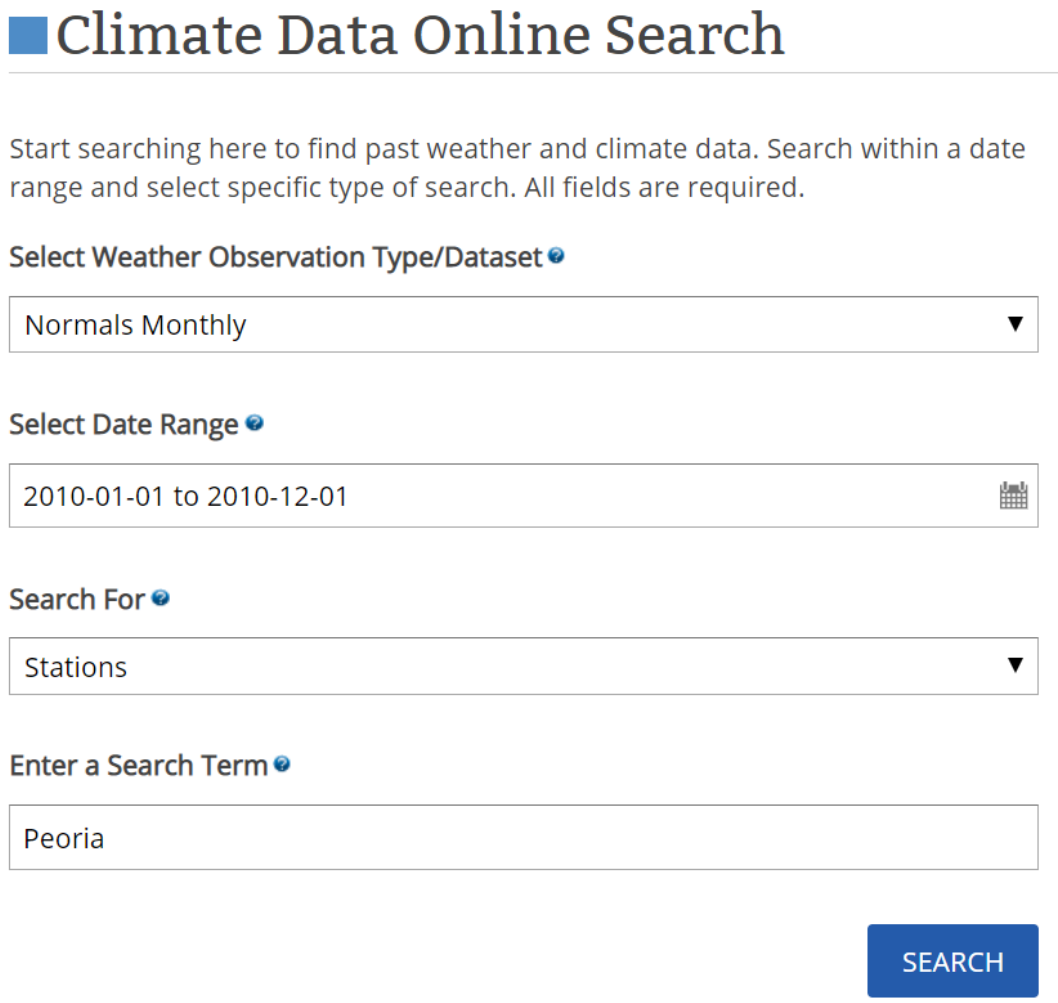
- Now we can estimate Monthly Therms for any Monthly Average Temperature!
- Let's go get some long-term average temperature data and see what therms use would be in a "typical" year

Normalize for weather

Back to the NOAA Weather Data

https://www.ncdc.noaa.gov/cdo-web/search

1. Select Normals Monthly this time
2. Date range will be an arbitrary year
3. Search for the same weather station you used for the baseline weather
4. The rest of the process is the same as for baseline weather



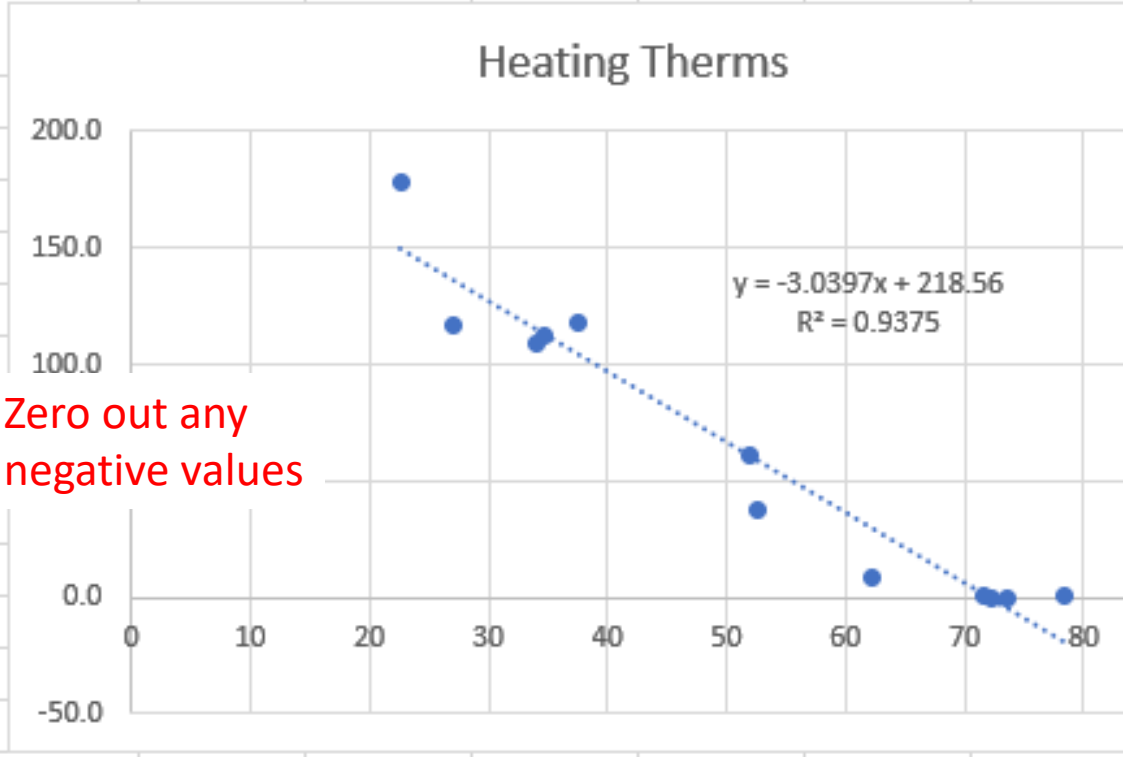
Normalize for weather

Calculate Projected Therms for Typical Weather

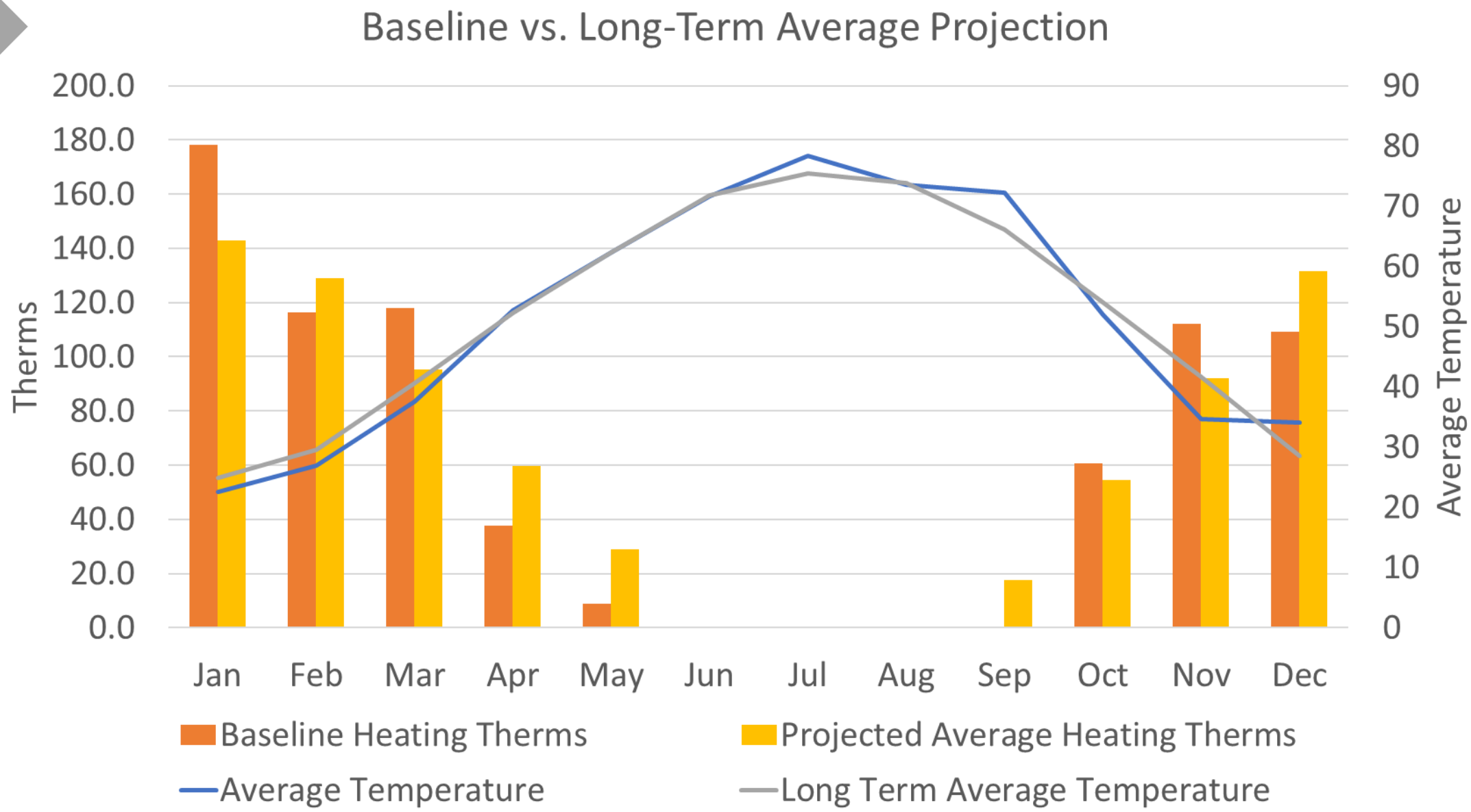
=-3.0397*U3 +218.56

Month	Average Temperature	Heating Therms	Long Term Average Temperature	Projected Heating Therms
Jan	22.6	178.3	24.9	=-3.0397*U3 +218.56
Feb	27	116.3	29.5	128.9
Mar	37.6	118.1	40.6	95.1
Apr	52.7	37.5	52.3	59.6
May	62.3	8.8	62.4	28.9
Jun	71.7	0.4	71.8	0.3
Jul	78.3	0.2	75.5	-10.9
Aug	73.5	0.0	73.8	-5.8
Sep	72.3	0.0	66.1	17.6
Oct	52	60.7	54	54.4
Nov	34.7	112.3	41.6	92.1
Dec	34.1	109.3	28.6	131.6
Total or Average	**51.57**	**742**	**51.76**	**734.8**

Zero out any negative values



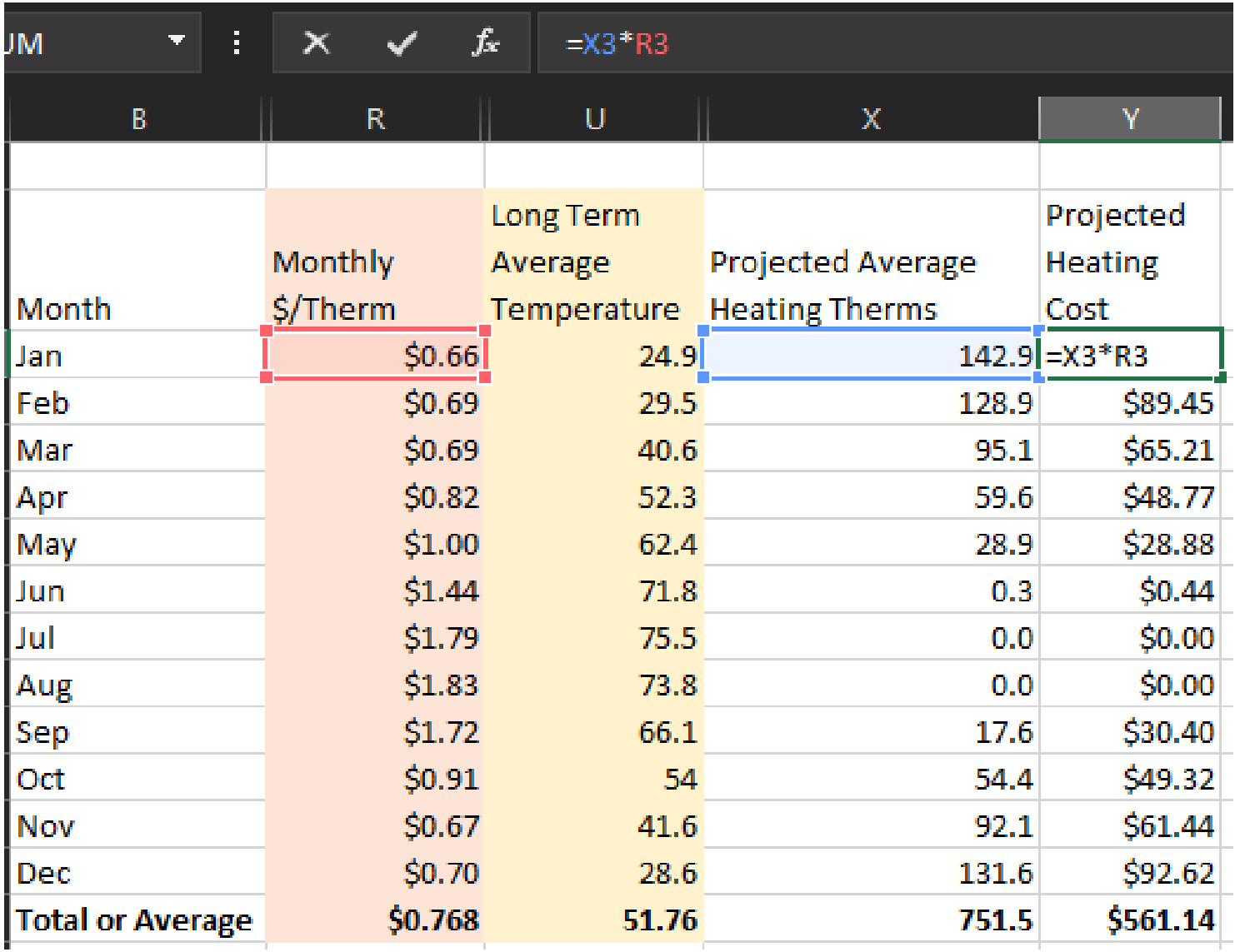
Normalize for weather



Normalize for weather

Estimate Typical Monthly Costs

1. Multiply the $/Therm you calculated for each month by the Projected Average Heating Therms



=X3*R3

	B	R	U	X	Y
	Month	Monthly $/Therm	Long Term Average Temperature	Projected Average Heating Therms	Projected Heating Cost
	Jan	$0.66	24.9	142.9	=X3*R3
	Feb	$0.69	29.5	128.9	$89.45
	Mar	$0.69	40.6	95.1	$65.21
	Apr	$0.82	52.3	59.6	$48.77
	May	$1.00	62.4	28.9	$28.88
	Jun	$1.44	71.8	0.3	$0.44
	Jul	$1.79	75.5	0.0	$0.00
	Aug	$1.83	73.8	0.0	$0.00
	Sep	$1.72	66.1	17.6	$30.40
	Oct	$0.91	54	54.4	$49.32
	Nov	$0.67	41.6	92.1	$61.44
	Dec	$0.70	28.6	131.6	$92.62
	Total or Average	**$0.768**	**51.76**	**751.5**	**$561.14**

Estimate bill savings

Estimate bill savings

Calculate % Savings

1. Use rated and/or field-measured efficiency to estimate % Savings

$$Eff_{existing}\left(\frac{1}{Eff_{existing}}-\frac{1}{Eff_{new}}\right)=\%\,Savings$$

Replace 15 SEER with 21 SEER

$$15\left(\frac{1}{15}-\frac{1}{21}\right)=29\%\,Savings$$

Estimate bill savings

Field Measured Performance

- NCI trains contractors to measure total system performance in the field
- ASHRAE 221P (New Proposed Standard) defines:
  - CSPr – Cooling System Performance Ratio
  - HSPr – Heating System Performance Ratio

$$\frac{Field\ Measured\ System\ Capacity}{Rated\ Equipment\ Capacity}$$

Estimate bill savings

Combining Equipment Rated Efficiency and CSPr or HSPr

$$Effective\ System\ Efficiency = SEER * CSPr$$
$$Effective\ System\ Efficiency = AFUE * HSPr$$
$$Effective\ System\ Efficiency = HSPF * HSPr$$

15 SEER with 57% CSPr

$$15 * 57\% = 8.6\ Effective\ System\ SEER$$

92 AFUE with 57% HSPr

$$92 * 57\% = 52\ Effective\ System\ AFUE$$

*Assumes no “thermal regain”. If ducts are in (partially) conditioned space you gain back some of the system losses

Estimate bill savings

Calculate Cost Savings

$$15\left(\frac{1}{15}-\frac{1}{21}\right)=29\%\ Savings$$

$$29\% * \$521.37 = \$151.20$$

$$Estimated\ Annual\ Electric\ Savings = \$151$$

Month	Baseline Projected Cooling Cost
Jan	$13.31
Feb	$17.30
Mar	$14.26
Apr	$19.87
May	$54.97
Jun	$166.98
Jul	$100.34
Aug	$56.54
Sep	$33.75
Oct	$13.22
Nov	$15.37
Dec	$15.48
Total	**$521.37**

Replacement Scenario Development – Bad Condenser

Cooling Savings Projection	SEER 15 Replacement	AC Upgrade	Duct Rennovation	AC Upgrade with Duct Rennovation
Baseline SEER/CSPr	15	15	57%	9
Upgrade SEER/CSPr	15	21	90%	19
% Savings	0%	29%	37%	55%
Baseline Cost	$521	$521	$521	$521
Cost Savings	$0	$149	$191	$286
Heating Savings Projection	Existing Furnace	Existing Furnace	Duct Rennovation	Existing Furnace With Duct Rennovation
Baseline AFUE/HSPr	92%	92%	62%	57%
Upgrade AFUE/HSPr	92%	92%	90%	83%
% Improvement	0%	0%	45%	45%
% Savings	0%	0%	31%	31%
Baseline Cost	$561	$561	$561	$561
Cost Savings	$0	$0	$175	$175
Total Heating and Cooling Annual Energy Cost Savings	**$0**	**$149**	**$366**	**$460**

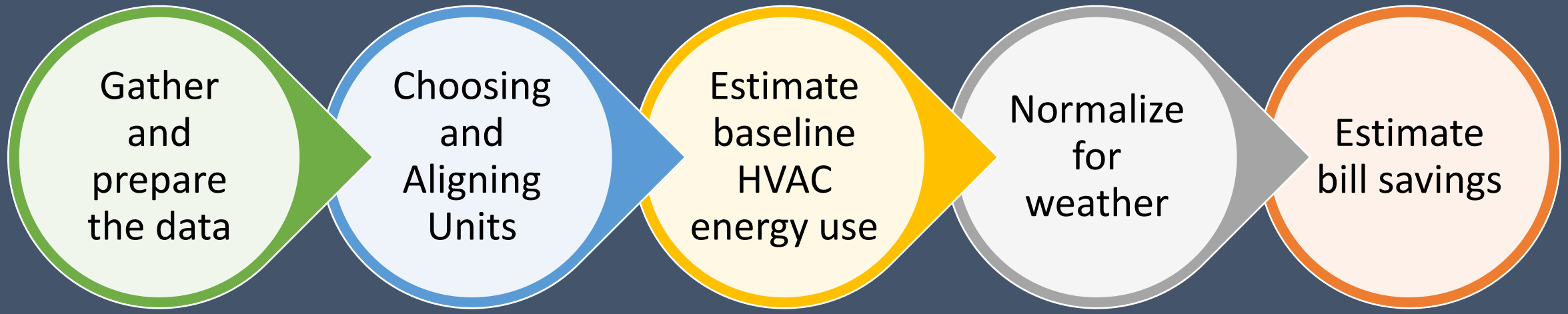
Comparison of Billing Analysis to Deemed

New AC and Duct Rennovation Savings Comparison	Billing Analysis	Deemed
kWh Savings	2936	884
% Cooling kWh Savings	55%	16%
Therms Savings	234	1662
% Heating Therms Savings	31%	221%

- Only 16% savings for more than doubling effective efficiency?
- 1662 therms savings? That's almost double what they used for the whole house, and more than twice what they used for just heating!

Month	Therms	Baseline Heating Therms
Jan	190.0	178.3
Feb	128.0	116.3
Mar	129.8	118.1
Apr	49.2	37.5
May	20.5	8.8
Jun	12.1	0.4
Jul	11.9	0.2
Aug	11.7	0.0
Sep	11.6	0.0
Oct	72.4	60.7
Nov	124.0	112.3
Dec	121.0	109.3
Total	**882.1**	**742**

Energy Analysis Process Overview



The Conversation at the Kitchen Table

- Explain that you've analyzed *their* situation, and have options and a recommendation
- Explain that your competitors may also provide estimates of savings, but advise them ask how the analysis was done
- If it was based on an average kWh/ton, kWh/square foot, "typical" operating hours or energy use, the estimates could be a long ways off

Present the Options

Replace Condenser

Total System Upgrade

Replace Condenser

- Like for like condenser replacement
- 15 SEER
- No energy savings
- Same comfort level
- 10 year parts only mfg. warranty

Total System Upgrade

- Complete new system including condenser, coil, thermostat, and duct renovation
- 21 SEER
- Improve System Performance from 57% to 90%
- About $460 annual electric and gas cost savings
  - 55% of electric bill and 31% of gas bill
- Improved comfort in summer and winter
- Lifetime compressor, 10 year unit replacement and parts mfg. warranty
- 10 year repair labor warranty

Be careful…

- Be clear that the energy savings are estimates based on their past utility bills
- Be cautious about simple payback estimates, oftentimes they don't pencil out in terms of pure energy savings for residential
- Vet the customer and their interest in high efficiency options before you spend the time to do a full analysis
  - If they can't take the time to get you the data, don't press them – they're probably not that concerned about their energy
- Don't spend more time than you need to on the analysis, if the prior year has had fairly typical weather, skip the weather normalization

Minimum Steps for Utility Billing Analysis

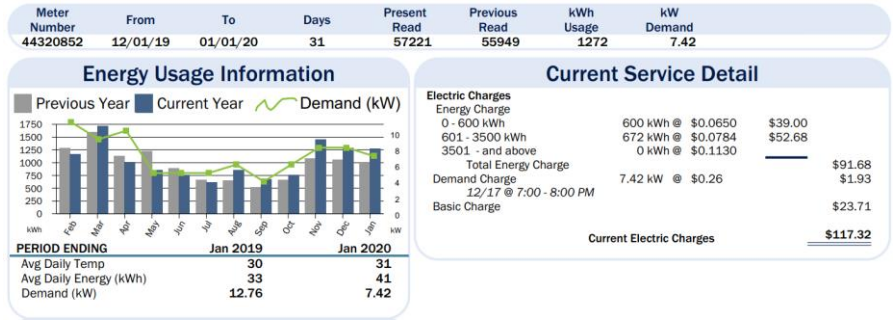
1. Obtain 1 year of utility billing data
2. Average the lowest 3 months of use to estimate base load
3. Subtract base load from total use to estimate heating or cooling use
4. Calculate $/therm or $/kWh, multiply by heating or cooling use to get heating or cooling cost
5. Estimate % savings for proposed options
6. Multiply % savings by heating or cooling cost to get cost savings

Resources and Tools

- Weather Data
  - NOAA CDO: https://www.ncdc.noaa.gov/cdo-web/search
  - Weather Underground: https://www.wunderground.com/history
  - Degree Days: https://www.degreedays.net/
- Analysis Tools
  - Universal Translator: http://utonline.org/cms/
  - ECAM: https://www.sbwconsulting.com/ecam/
- Field Measured System Performance:
  - NCI Training: https://www.nationalcomfortinstitute.com/pro/index.cfm?pid=3084
  - ASHRAE Standard 221P: https://www.ashrae.org/technical-resources/standards-and-guidelines/titles-purposes-and-scopes

Conclusion

- The customer's first two questions
- The usual answer
- The better answer
- Performing a basic utility bill analysis
  - Gathering and cleaning the data
  - Choosing units: kWh, therms, or dollars
  - Estimating baseline HVAC energy use
  - Weather normalization
  - Estimating bill savings
- The conversation at the kitchen table
- Resources and tools
- Summary and Conclusion



Meter Number	From	To	Days	Present Read	Previous Read	kWh Usage	kW Demand
44320852	12/01/19	01/01/20	31	57221	55949	1272	7.42

Energy Usage Information

Previous Year | Current Year | Demand (kW)

PERIOD ENDING	Jan 2019	Jan 2020
Avg Daily Temp	30	31
Avg Daily Energy (kWh)	33	41
Demand (kW)	12.76	7.42

Current Service Detail

Electric Charges			
Energy Charge			
0 - 600 kWh	600 kWh @	$0.0650	$39.00
601 - 3500 kWh	672 kWh @	$0.0784	$52.68
3501 - and above	0 kWh @	$0.1130	
Total Energy Charge			$91.68
Demand Charge	7.42 kW @	$0.26	$1.93
12/17 @ 7:00 - 8:00 PM			
Basic Charge			$23.71
Current Electric Charges			$117.32