BEFORE THE
PUBLIC SERVICE COMMISSION OF UTAH

In the Matter of the Investigation of the Costs and Benefits
of Pacificorp's Net Metering Program

Docket No. 14-035-114

EXHIBIT ACCOMPANYING DIRECT TESTIMONY OF
ELIAH GILFENBAUM ON BEHALF OF
ENERGY FREEDOM COALITION OF AMERICA

Exhibit EG-2

Rocky Mountain Power response to Vote Solar Data Request 1.49 (w/ attachment)

14-035-114/ Rocky Mountain Power
February 21, 2017
Vote Solar Data Request 1.49

Vote Solar Data Request 1.49

With respect to the Direct Testimony of Joelle Steward, lines 489-493, please provide the derivation of the coincidence factor used to recognize the diversity of usage that is considered with the initial sizing of transformers, in executable excel format with all formulae intact.

(a) Is the same factor used across the all transformers serving residential customers? If not, please explain and support any differentiation.

Response to Vote Solar Data Request 1.49

Transformer sizing is done per PacifiCorp distribution construction standard DA411. Please refer to Attachment Vote Solar 1.49.

(a) Yes

DA 411 General—Residential Electrical Demand

Scope

This document provides guidance on electrical demand estimation and service transformer sizing for single- and multi-family residential dwellings. Covered topics include residential load estimation, load factor, coincidence factor, and service transformer sizing.

Refer to PacifiCorp Engineering Policy 19, *Residential Subdivision Design Policy,* for additional information on design.

Load Estimation

Several factors must be known or assumed in order to accurately estimate peak electrical demand. Even with accurate information or profile metering, changes in the number of occupants, life style, major appliances, or remodels can result in significant changes. In the absence of unusual conditions such as temperature extremes or large block loads the demand estimates provided below are appropriate for sizing transformers across the company's service territory.

Table 1 and Table 2 below show estimated peak demands for single-family homes.

Table 1—Summer Peaking, Single-Family, Ducted Heat Source: Gas, Heat Pump, Other
Estimated Peak Demand (kVA) per Residence

Home Size (Effective/Total ft.²)		< 1300 ft.²		1300-2000 ft.²		2001-3500 ft.²		3501-4500 ft.²		4501-6000 ft.²	
Number of Customers	CF	Peak Load	XFMR Size	Peak Load	XFMR Size	Peak Load	XFMR Size	Peak Load	XFMR Size	Peak Load	XFMR Size
1	1	8	**25**	10	**25**	14	**25**	17	**25**	22	**25**
2	0.9	15	**25**	18	**25**	26	**50**	31	**50**	40	**50**
3	0.86	21	**25**	26	**50**	37	**50**	44	**50**	57	**75**
4	0.82	27	**50**	33	**50**	46	**50**	56	**75**	73	**75**
5	0.78	32	**50**	39	**50**	55	**75**	67	**75**	86	**100[1]**
6	0.76	37	**50**	46	**50**	64	**75**	78	**100[1]**	101	**167[1]**
7	0.74	42	**50**	52	**75**	73	**75**	89	**100[1]**	114	**167[1]**
8	0.72	47	**50**	58	**75**	81	**100[1]**	98	**100[1]**	127	**167[1]**
9	0.71	52	**75**	64	**75**	90	**100[1]**	109	**167[1]**	141	**167[1]**
10	0.7	56	**75**	70	**75**	98	**100[1]**	119	**167[1]**	154	**167[1]**
11	0.7	62	**75**	77	**100[1]**	108	**167[1]**	131	**167[1]**	170	*
12	0.7	68	**75**	84	**100[1]**	118	**167[1]**	143	**167[1]**	185	*
13	0.7	73	**75**	91	**100[1]**	128	**167[1]**	155	**167[1]**	201	*
14	0.7	79	**100[1]**	98	**100[1]**	138	**167[1]**	167	**167[1]**	216	*
15	0.7	84	**100[1]**	105	**167[1]**	147	**167[1]**	179	*	231	*
16	0.7	90	**100[1]**	112	**167[1]**	157	**167[1]**	191	*	247	*
17	0.7	96	**100[1]**	119	**167[1]**	167	**167[1]**	203	*	262	*
18	0.7	101	**167[1]**	126	**167[1]**	177	*	215	*	278	*
19	0.7	107	**167[1]**	133	**167[1]**	187	*	227	*	293	*
20	0.7	112	**167[1]**	140	**167[1]**	196	*	238	*	308	*

[1] Consult with engineering prior to installing transformers 100 kVA or greater for single-phase, residential services.

* Multiple service transformers required.

Table 2—Winter Peaking, Single-Family, Ducted Heat Source: Resistive Electric Estimated Peak Demand (kVA) per Residence

Home Size (Effective/Total ft.²)		< 1300 ft.²		1300-2000 ft.²		2001-3500 ft.²		3501-4500 ft.²		4501-6000 ft.²	
Number of Customers	CF	Peak Load	XFMR Size	Peak Load	XFMR Size	Peak Load	XFMR Size	Peak Load	XFMR Size	Peak Load	XFMR Size
1	1	13	**25**	17	**25**	20	**25**	25	**25**	30	**50**
2	0.77	21	**25**	27	**25**	31	**50**	39	**50**	47	**50**
3	0.70	28	**50**	36	**50**	42	**50**	53	**50**	63	**75**
4	0.67	35	**50**	46	**50**	54	**50**	67	**75**	81	**75**
5	0.64	42	**50**	55	**50**	64	**75**	80	**75**	96	**100[1]**
6	0.62	49	**50**	64	**75**	75	**75**	93	**100[1]**	112	**167[1]**
7	0.60	55	**50**	72	**75**	84	**100[1]**	105	**100[1]**	126	**167[1]**
8	0.59	62	**75**	81	**75**	95	**100[1]**	118	**167[1]**	142	**167[1]**
9	0.58	68	**75**	89	**100[1]**	105	**100[1]**	131	**167[1]**	157	**167[1]**
10	0.57	75	**75**	97	**100[1]**	114	**167[1]**	143	**167[1]**	171	**167[1]**
11	0.57	82	**75**	107	**100[1]**	126	**167[1]**	157	**167[1]**	189	*
12	0.57	89	**100[1]**	117	**167[1]**	137	**167[1]**	171	**167[1]**	206	*
13	0.57	97	**100[1]**	126	**167[1]**	149	**167[1]**	186	*	223	*
14	0.57	104	**100[1]**	136	**167[1]**	160	**167[1]**	200	*	240	*
15	0.57	112	**167[1]**	146	**167[1]**	171	**167[1]**	214	*	257	*
16	0.57	119	**167[1]**	156	**167[1]**	183	**167[1]**	228	*	274	*
17	0.57	126	**167[1]**	165	**167[1]**	194	*	243	*	291	*
18	0.57	134	**167[1]**	175	**167[1]**	206	*	257	*	308	*
19	0.57	141	**167[1]**	185	*	217	*	271	*	325	*
20	0.57	149	**167[1]**	194	*	228	*	285	*	342	*

[1] Consult with engineering prior to installing transformers 100 kVA or greater for single-phase, residential services.

* Multiple service transformers required.

Supplemental Calculations

1.Square Footage and Heat Source Based Model:

Conservative estimates for peak residential demand are provided in Table 3 and Table 4. Estimates vary with the ducted heat source and total square footage, in all cases ducted air conditioning is assumed. Quick reference tables are provided to assist in sizing service transformers with multiple residences in the same classification. Peak demand estimates may also be made using load factor conversions with a nearby comparable or historical meter data.

Table 3—Multi-Family / Apartment
Estimated Peak Demand (kVA) Per Residence

Ducted Heat Source	< 800 ft.²	801 - 1000 ft.²	1001 - 1500 ft.²
Gas, Heat Pump, Other	5	6	7
Resistive	8	9	11

Table 4—Single-Family
Estimated Peak Demand (kVA) Per Residence

Ducted Heat Source	< 1300 ft.²	1300-2000 ft.²	2001-3500 ft.²	3501-4500 ft.²	4501-6000 ft.²
Gas, Heat Pump, Other	8	10	14	17	22
Resistive	13	17	20	25	30

2.Load Factor (Energy to Demand Conversion)

Load factor (LF) can be used to estimate peak electrical demand or energy consumption when one of the factors is unknown. Load factors vary seasonally and are highly dependent on the types of major appliances in use and their duty cycle. Typical load factors for residential dwellings are provided in Table 5. For a fixed amount of energy consumption the estimated peak demand will increase as the load factor decreases as shown in Figure 1.

Load factor calculations may be used to estimate peak electrical demand by pulling historical usage for the customer in question or comparable sites nearby. For the residential load class an average power factor (PF) of 0.95 may be assumed. Equations and examples are provided to assist in manual calculations.

Table 5—Typical Residential Load Factor

Season	Ducted Heat Source	Load Factor
Shoulder	Minimal Heat/Cooling	30% to 45%
Summer	Evaporative Cooling	30% to 45%
	Air Conditioning	30% to 40%
Winter	Non-Resistive Heat	30% to 40%
	Resistive Heat	25% to 40%

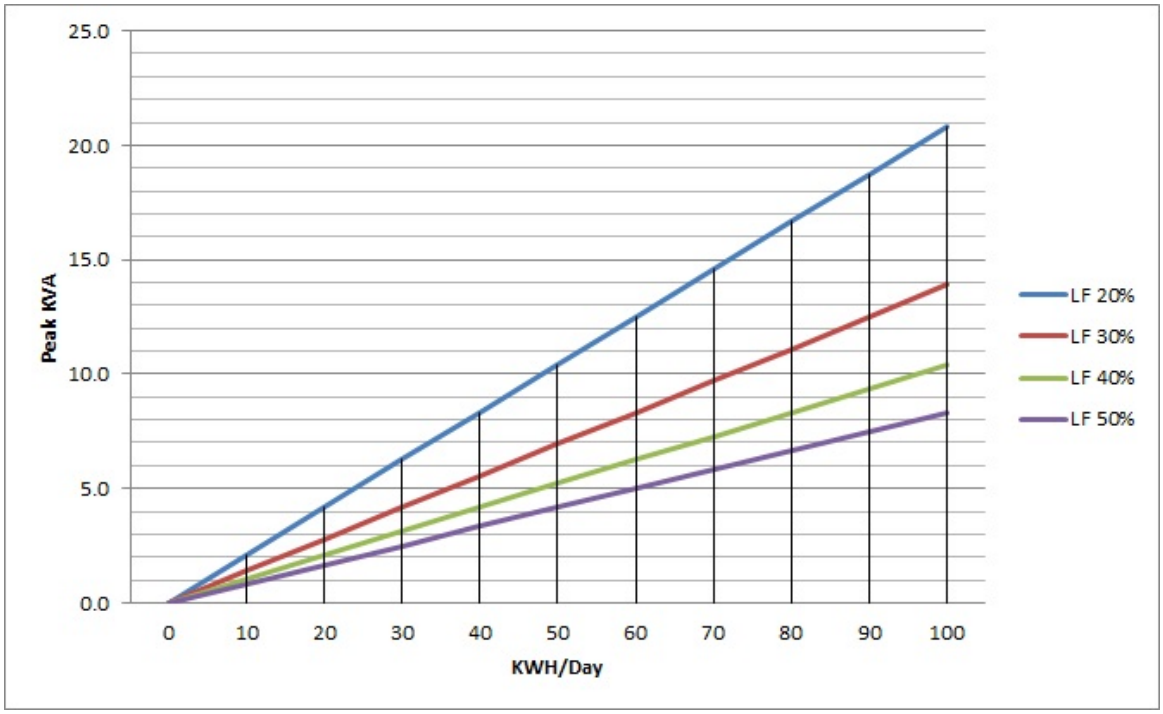

Figure 1—Estimating Load with Historical Usage

$$Load Factor (LF) = \frac{kWh}{\left(Peak\ kW\right) \times Number\ of\ Days \times 24 \frac{hrs}{day}}$$

$$Peak\ kW = \frac{kWh}{LF \times Number\ of\ Days \times 24 \frac{hrs}{day}}$$

$$Peak\ kVA = \frac{PeakkW}{PF}$$

Example Calculating Load Factor (LF)

1. Total kWh in billing period = 975 kWh
2. Peak demand registered = 5.6 kW
3. Number of days in billing period = 29

$$Load\ Factor\,(LF) = \frac{975\ kWh}{5.6\ kW \times 29\ days \times 24\ \frac{hrs}{day}} = 0.25\ or\ 25\%$$

Example Calculating Peak kW and kVA

1. Total kWh in billing period = 975 kWh
2. Load factor = 40%
3. Assumed power factor (PF) = 0,95
4. Number of days in billing period = 29

$$Peak\ kW = \frac{975\ kWh}{0.4 \times 29\ days \times 24\ \frac{hrs}{day}} = 3.5\ kW$$

$$Peak\ kVA = \frac{3.5\ kW}{0.95\ PF} = 3.68\ kVA$$

3.Block Loads, Climate Adjustment, and Flicker Sources

Limitations on block load size for residential services are addressed in the PacifiCorp *Electric Service Requirements Manual* under load requirements. In general adjustments are not necessary for infrequently used loads with limited duty cycles commonly associated with home shops for wood/metal working or electric lifts. Adjustments to demand estimates may be necessary for uncommon conditions, some of which some of the most common are discussed below.

3.1. Heating and Cooling

Heating and cooling loads are accounted for in the demand estimates in Table 3 and Table 4. These estimates are valid for all climate zones assuming the loads fall at or below the median ranges shown Table 6 and Table 7. Climatic adjustments may be necessary for older homes with less insulation, unique floor plans, or in the extremes of climatic conditions. These adjustments should be made in coordination with load sheets provided by the customer.

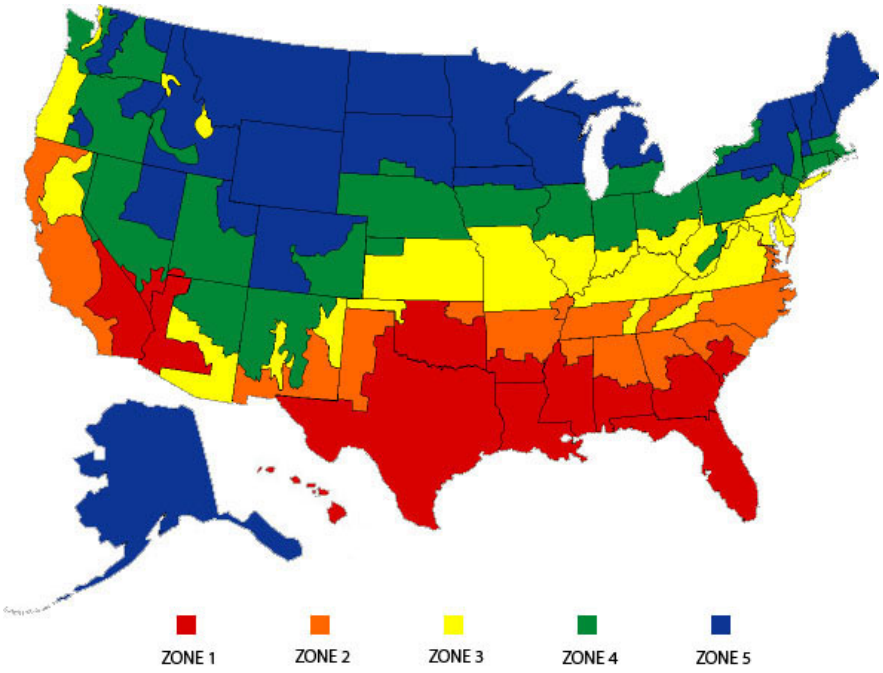

Figure 2—U.S. Climate Zones

Table 6—AC Tonnage vs. Finished Square Footage

	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5
1.5 Tons	600 - 900 ft²	600 - 950 ft²	600 - 1000 ft²	700 - 1050 ft²	700 - 1100 ft²
2 Tons	907 - 1200 ft²	951 - 1250 ft²	1001 - 1300 ft²	1051 - 1350 ft²	1101 - 1400 ft²
2.5 Tons	1201 - 1500 ft²	1251 - 1550 ft²	1301 - 1600 ft²	1351 - 1600 ft²	1401 - 1650 ft²
3 Tons	1501 - 1800 ft²	1501 - 1850 ft²	1601 - 1900 ft²	1601 - 2000 ft²	1651 - 2100 ft²
3.5 Tons	1801 - 2100 ft²	1851 - 2150 ft²	1901 - 2200 ft²	2001 - 2250 ft²	2101 - 2300 ft²
4 Tons	2101 - 2400 ft²	2151 - 2500 ft²	2201 - 2600 ft²	2251 - 2700 ft²	2301 - 2700 ft²
5 Tons	2401 - 3000 ft²	2501 - 3100 ft²	2601 - 3200 ft²	2751 - 3300 ft²	2701 - 3300 ft²

Note: Assume multiple AC units for residences for AC loads larger than 5 Tons

Table 7—Resistive Heat Load vs. Finished Square Footage

kW per 1000 ft²	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5
Lower Range	4.4 kW	5.9 kW	8.8 kW	10.3 kW	11.8 kW
Median	7.4 kW	8.8 kW	11 kW	12.5 kW	14.7 kW
Upper Range	10.3 kW	11.8 kW	13.2 kW	14.7 kW	17.6 kW

3.2. Electric Vehicle (EV) Chargers

Electric vehicle chargers are considered a unique load and not accounted for in standard estimates. While the adoption of electric vehicles is increasing throughout the company's service territory the technology is evolving rapidly with customer behavior, charge rates and durations varying significantly. Isolated electric vehicle chargers are not expected to cause problems, however multiple electric vehicle chargers connected to the same set of secondary conductors or transformers may result in equipment overloads.

If the presence of an electric vehicle is known at the time of construction or service upgrade, 6 kVA should be added to the peak demand estimate for that residence. Table 8 provides peak charge rates for standard electric vehicle chargers currently on the market, however most vehicles are not currently capable of charging at the peak rates listed.

Table 8—Electric Vehicle Peak Charge Rates

Type	Voltage	Peak Charge Rate	Demand Adder per Dwelling
Level 1	120 V	1.92 kW / 16 A	1.5 kVA
Level 2a	240 V	7.68 kW / 32 A	6 kVA
Level 2b		19.20 kW / 80 A	18 kVA

4.Coincidence Factor

Coincidence factors are applied when more than one customer is served by a single transformer or set of conductors. Since all customers generally do not reach peak load at the same moment, the total load on cables or on the transformer is generally less than the sum of the individual peak loads.

Coincidental peak demand is determined by adding up the individual peak demands and multiplying by a coincidence factor. Coincidence factor varies with number of customers. The numbers provided in Table 9 apply to single-and multi-family construction.

Table 9—Coincidence Factor

Number Of Customers	1	2	3	4	5	6	7	8	9	10	11 or more
CF for Summer Loads	1.0	.90	.86	.82	.78	.76	.74	.72	.71	.70	.70
CF for Winter Loads	1.0	.77	.70	.67	.64	.62	.60	.59	.58	.57	.56

Example

Determine the coincidental peak demand for the group of single-family homes below assuming summer peaking with natural gas as the primary heat source.

Home Size	1500 ft.²	2500 ft.²	3000 ft.²
Number of Homes	1	2	2 w/ 1 EV

Step 1:

1. Determine the estimated peak demand for each residence using Table 3 and Table 4.
2. Add the estimated peak demands for each residence.
3. Determine coincidence factor based on number of residences and peaking using Table 9.

Size of House	Individual Demand	Number of Homes	Sum of Demands
1500 ft²	10 kVA	1	10 kVA
2500 ft²	14 kVA	2	28 kVA
3000 ft²	14 kVA	1	14 kVA
3000 ft² w/ EV	20 kVA	1	20 kVA
	Totals	**5**	**72 kVA**

Step 2:

1. Determine the coincidental demand by multiplying the sum of demands by the coincidence factor.

$$Coincidental Demand = CF \times Sum\ of\ Demands = 0.78 \times 72\,kVA = 56.1\ kVA$$

5.Service Transformer Sizing

Service transformers are sized to serve peak coincidental load while limiting voltage drop and flicker to acceptable levels. Service transformer size also impacts the maximum available fault current at the customer's service entrance. The short-circuit current rating (SCCR) of the customer's service entrances may limit the size of transformer that may be selected.

For new construction and service upgrades service transformers should be sized to serve the estimated coincidental peak load without exceeding limits defined in Table 10. Summer peaking should be assumed for most residential services unless a ducted resistive heat source is present or the area is known to be winter peaking. Table 11 should be used in determining whether or not an in-service transformer is overloaded.

Table 10—Conservative Transformer Loading Guidlines

100% Summer Loading, 110% Winter Loading					
Transformer Size	25 kVA	50 kVA	75 kVA	100 kVA	167 kVA
Summer Range	0-25	26-50	51-75	76-100	101-167
Winter Range	0-28	29-55	56-83	84-110	111-184

Table 11—Maximum Transformer Loading Guidelines

130% Summer Loading, 150% Winter Loading					
Transformer Size	25 kVA	50 kVA	75 kVA	100 kVA	167 kVA
Summer Range	0-33	34-65	66-98	99-130	131-218
Winter Range	0-38	39-75	76-113	114-150	151-251

Example

Determine the required service transformer size to serve the group of single-family homes below assuming summer peaking with natural gas as the primary heat source.

Size of House	Individual Demand	Number of Homes	Sum of Demands
1500 ft²	10 kVA	1	10 kVA
2500 ft²	14 kVA	2	28 kVA
3000 ft²	14 kVA	1	14 kVA
3000 ft² w/ EV	20 kVA	1	20 kVA
Totals		**5**	**72 kVA**

$$Coincidental\ Demand = CF \times Sum\ of\ Demands = 0.78 \times 72\ kVA = 56.1\ kVA$$

$$Required\ Transformer\ Size = 75\,kVA\,(kVA\ Range = 51 - 75)$$

Table 12—Summer Peaking, Multi-Family, Ducted Heat Source: Gas, Heat Pump, Other

Home Size (Effective/Total ft.²)		< 800 ft.²		801-1000 ft.²		1001-1500 ft.²	
Number of Customers	CF	Peak Load	XFMR Size	Peak Load	XFMR Size	Peak Load	XFMR Size
1	1	5	**25**	6	**25**	7	**25**
2	0.9	9	**25**	11	**25**	13	**25**
3	0.86	13	**25**	16	**25**	19	**25**
4	0.82	17	**25**	20	**25**	23	**25**
5	0.78	20	**25**	24	**25**	28	**50**
6	0.76	23	**25**	28	**50**	32	**50**
7	0.74	26	**50**	32	**50**	37	**50**
8	0.72	29	**50**	35	**50**	41	**50**
9	0.71	32	**50**	39	**50**	45	**50**
10	0.7	35	**50**	42	**50**	49	**50**
11	0.7	39	**50**	47	**50**	54	**75**
12	0.7	42	**50**	51	**75**	59	**75**
13	0.7	46	**50**	55	**75**	64	**75**
14	0.7	49	**50**	59	**75**	69	**75**
15	0.7	53	**75**	63	**75**	74	**75**
16	0.7	56	**75**	68	**75**	79	**100[1]**
17	0.7	60	**75**	72	**75**	84	**100[1]**
18	0.7	63	**75**	76	**100[1]**	89	**100[1]**
19	0.7	67	**75**	80	**100[1]**	94	**100[1]**
20	0.7	70	**75**	84	**100[1]**	98	**100[1]**

[1] Consult with engineering prior to installing transformers 100 kVA or greater for single-phase, residential services.

Table 13—Winter Peaking, Multi-Family, Ducted Heat Source: Resistive Electric Estimated Peak Demand (kVA) per Residence

Home Size (Effective/Total ft.²)		< 800 ft.²		801-1000 ft.²		1001-1500 ft.²	
Number of Customers	CF	Peak Load	XFMR Size	Peak Load	XFMR Size	Peak Load	XFMR Size
1	1	8	**25**	9	**25**	11	**25**
2	0.77	13	**25**	14	**25**	17	**25**
3	0.70	17	**25**	19	**25**	24	**25**
4	0.67	22	**25**	25	**25**	30	**50**
5	0.64	26	**25**	29	**50**	36	**50**
6	0.62	30	**50**	34	**50**	41	**50**
7	0.60	34	**50**	38	**50**	47	**50**
8	0.59	38	**50**	43	**50**	52	**50**
9	0.58	42	**50**	47	**50**	58	**75**
10	0.57	46	**50**	52	**50**	63	**75**
11	0.57	51	**50**	57	**75**	69	**75**
12	0.57	55	**50**	62	**75**	76	**75**
13	0.57	60	**75**	67	**75**	82	**75**
14	0.57	64	**75**	72	**75**	88	**100[1]**
15	0.57	69	**75**	77	**75**	95	**100[1]**
16	0.57	73	**75**	83	**75**	101	**100[1]**
17	0.57	78	**75**	88	**100[1]**	107	**100[1]**
18	0.57	83	**75**	93	**100[1]**	113	**167[1]**
19	0.57	87	**100[1]**	98	**100[1]**	120	**167[1]**
20	0.57	92	**100[1]**	103	**100[1]**	126	**167[1]**

[1] Consult with engineering prior to installing transformers 100 kVA or greater for single-phase, residential services.