From:	Kari West
To:	Kelly Passauer
Subject:	For September Commission Meeting
Date:	Monday, August 24, 2020 10:13:10 AM
Attachments:	City of Independence TS 712603 Power Factor Correction.pdf

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Hi Kelly,

Here is the information for the commission meeting regarding Power Factor Correction. I will talk about potential savings, but I need to revisit based on usage through at least July. Let me know what else you may need.

Periodically, I review accounts and look for ways for customers to be more efficient and that can lead to saving money. I have targeted possible savings in the Central Energy Plant. Upon review of 2019 usage, the Central Energy Plant Power Factor hit a low of 65% and in the hottest month of the year with air conditioning running, only hit 80%. So what does that mean to the City of Independence? Evergy bills on a 90% power factor. You are paying an adjustment every month you are below 90%, which in turn increases multiple segments of your bill. You can correct your Power Factor, and long term save the city some money.

Evergy's Recommendation:

- Do your due diligence and research options for power factor correction. There are several companies who specialize in this type of work and can put together a detailed plan to address this at your facility.
- Evergy's Distribution Engineers have provided a free assessment including a Power Factor Analysis on the Central Energy Plant which can be provided as a baseline report for corrective actions. (Included in this packet for review.)
- If you are interested in learning more about the payback of additional equipment, I would suggest taking proposals to determine what are the full needs of the plant whether it would be an automatic capacitor bank installed at the main service, a static bank, or even identifying the equipment lagging your power factor and addressing it at the source. That way you have a better idea of cost and projected work to determine if the payback is right for you or not.

Kari West
Lead Customer Solutions Manager
Evergy

Kari.West@evergy.com
O: 620-235-2503 **M:** 620-249-6766
Evergy.com

From: Kari West
To: Kelly Passauer
Subject: Also please include...
Date: Monday, August 24, 2020 3:31:21 PM
Attachments: image001.png

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Not to complicate things, but, please include this with the info on Power Factor. I don't want to get into the weeds, but we will likely have to for a little bit.

WHAT IS POWER FACTOR:

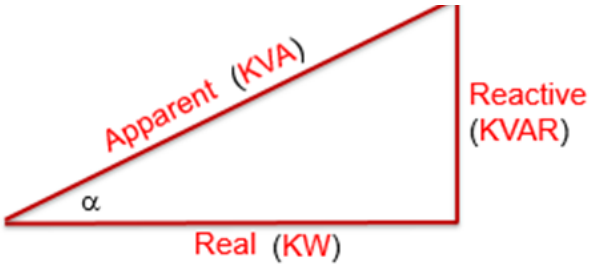
Power factor is awkward to understand at best. I'm going to try to break it down. When you hear utilities talk about Power Factor, you'll hear us talk a lot about KVAR.

- KVAR is the portion of power that the electric line has to REACT to for the INDUCTIVE loads
  - Resistive loads such as standard lighting and resistance heating has a power factor already of near 1.0 (100%)
  - Motors without Variable Frequency Drives are generally not efficient users
    - In this case, motors turn because a magnetic field is generated and collapsed in the motor – this induces rotation. Every time that magnetic field is created, it takes additional power. When it collapses, that power is fed back to the source.

- Regardless, as a utility we must **REACT** to that temporary need (demand/KW). So, the utility must provide more than is actually being consumed after start-up.

- There are ways to correct that, and while you spend a little upfront on correction equipment, over the long term, you generally save on your bill.
  - Correction applied to inductive loads are made with capacitors which store the reactive power, reducing what is needed from the utility.

- Capacitors can be thought as storing the power that would have been fed back to the utility, thereby reducing the reactive load that the utility sees and improving power factor.



REAL (TRUE) Power = what is truly being consumed

REACTIVE (INDUCTIVE) Power = the extra power the utility must provide to build magnetic fields. (Ping-Pong)

APPARENT Power = what the utility must apparently provide to accommodate the REAL and REACTIVE power.

KW, KVA, KVAR – are similar labels that help define what type of power is being referenced.

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Kari West
Lead Customer Solutions Manager
Evergy

Kari.West@evergy.com
O: 620-235-2503 **M:** 620-249-6766
Evergy.com

Power Factor Correction Report

City of Independence TS 712603 Taylor 12-4

Issued on February 10th, 2020

Introduction

Evergy has monitored the meter for the City of Independence at 800 W. Myrtle St. in Independence. The recorder at TS 712603 was set from 1/30/20 to 2/6/20. Below you will see the analysis of this data. The purpose of this report is to display monitored load data (Voltage, Current, KVA, KW, KVAR, Voltage and Current Harmonics) collected at the customer's meter. The customer should be able to take this report to an engineering consulting firm and work with them to design and install power factor correction equipment and/or harmonic filters.

Total Power and Power Factor

Figure 1 is the graph for the total apparent power (KVA), real power (KW), reactive power (KVAR), and Power Factor.

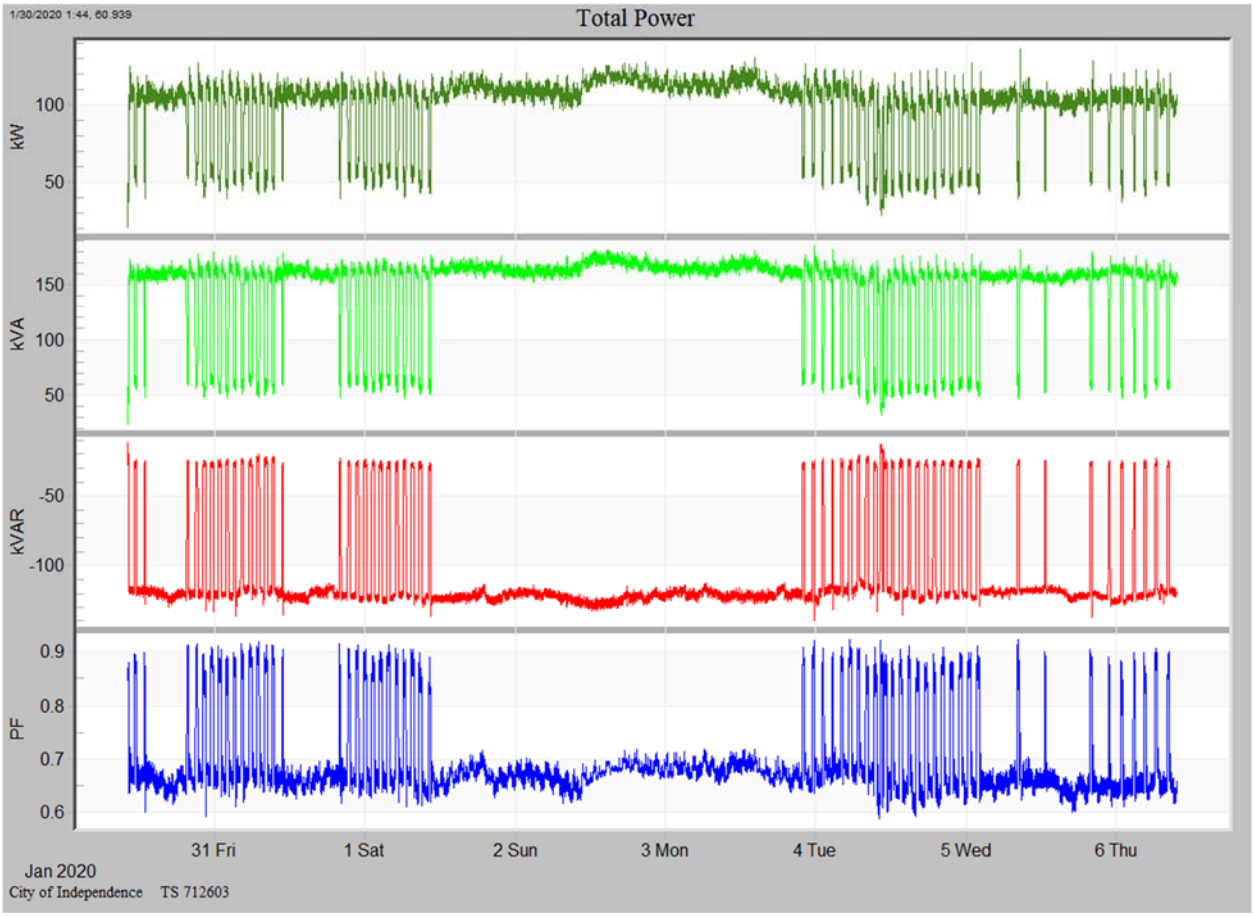

Figure 1: Total Power and Power Factor

This graph shows that the facility's power factor is lagging during normal operating hours due to inductive load. For a unity power factor, the reactive power would need to be zero. This recorder was left on overnight so we could see what the minimum VAR usage would be. From the graph, it can be determined

that the facility consumes an average of 120 KVAR with a peak of 135 KVAR during running hours, and a minimum of 15 KVAR. During this time, the power factor fluctuates between 65% and 90%.

Voltage and Current Total Harmonic Distortion

It is important to take into consideration harmonics when installing capacitors. The reason for this is capacitance introduces the possibility of harmonic resonance to the system. An improperly tuned capacitor bank could cause damage or nuissance tripping of customer equipment if the system goes into resonance. Therefore, Evergy encourages our customers to work with a consultant to ensure the addition of capacitance does not cause any unexpected issues.

The voltage and current total harmonic distortions are shown in figures 2 & 3. The voltage harmonic levels are within the allowances set by IEEE Standard 519 shown in Figure 6.

Figure 2: Voltage Total Harmonic Distortion per Channel

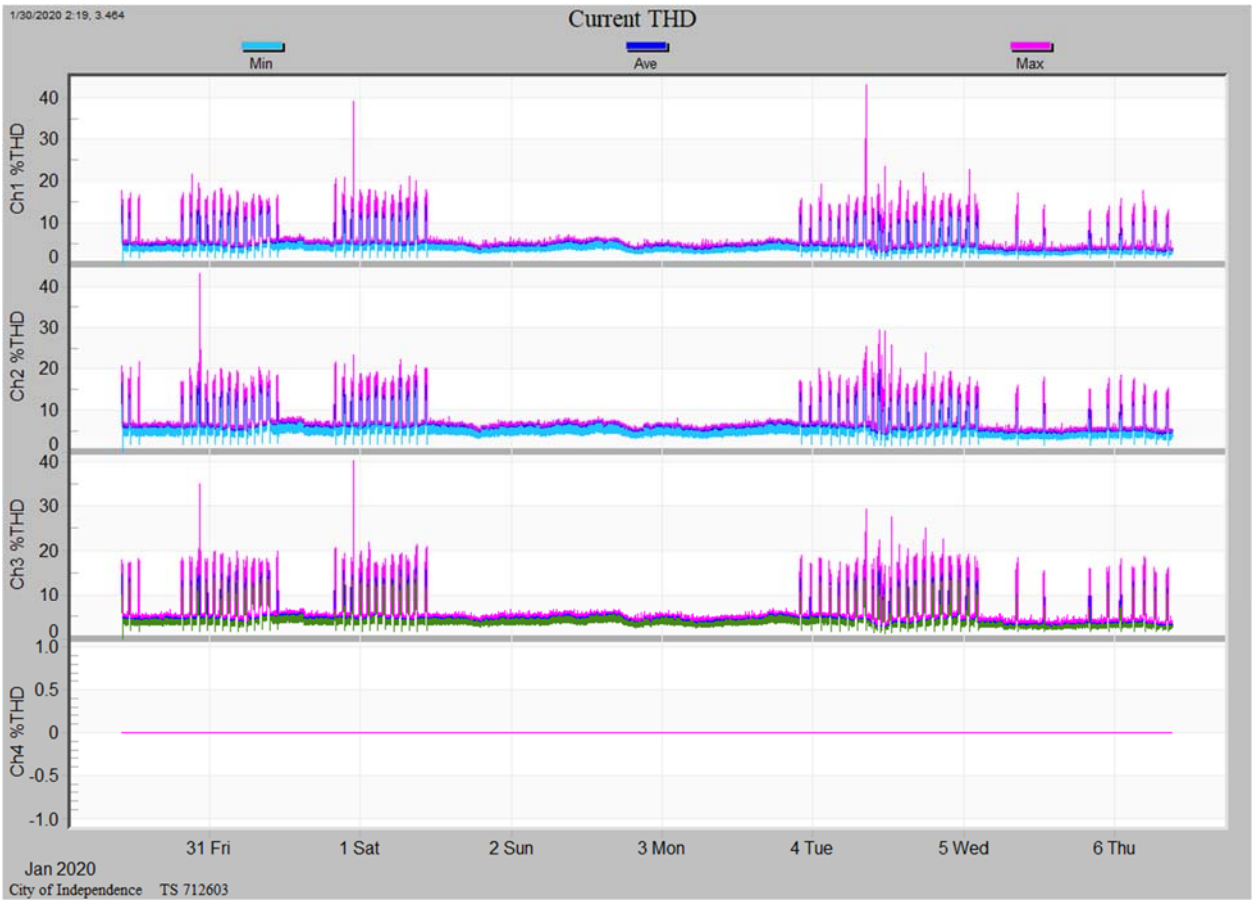

Figure 3: Current Total Harmonic Distortion per Channel

Individual Voltage Harmonics

Figure 4 is the breakdown of voltage harmonic content. Most harmonic content present is the 7th. The individual voltage harmonic content is below the limit set by IEEE Standard 519 shown in Figure 6. Take note that the graph scale is in voltage magnitude and not percent. The percent is found in the ratio of the individual harmonics over the fundamental (1st) harmonic.

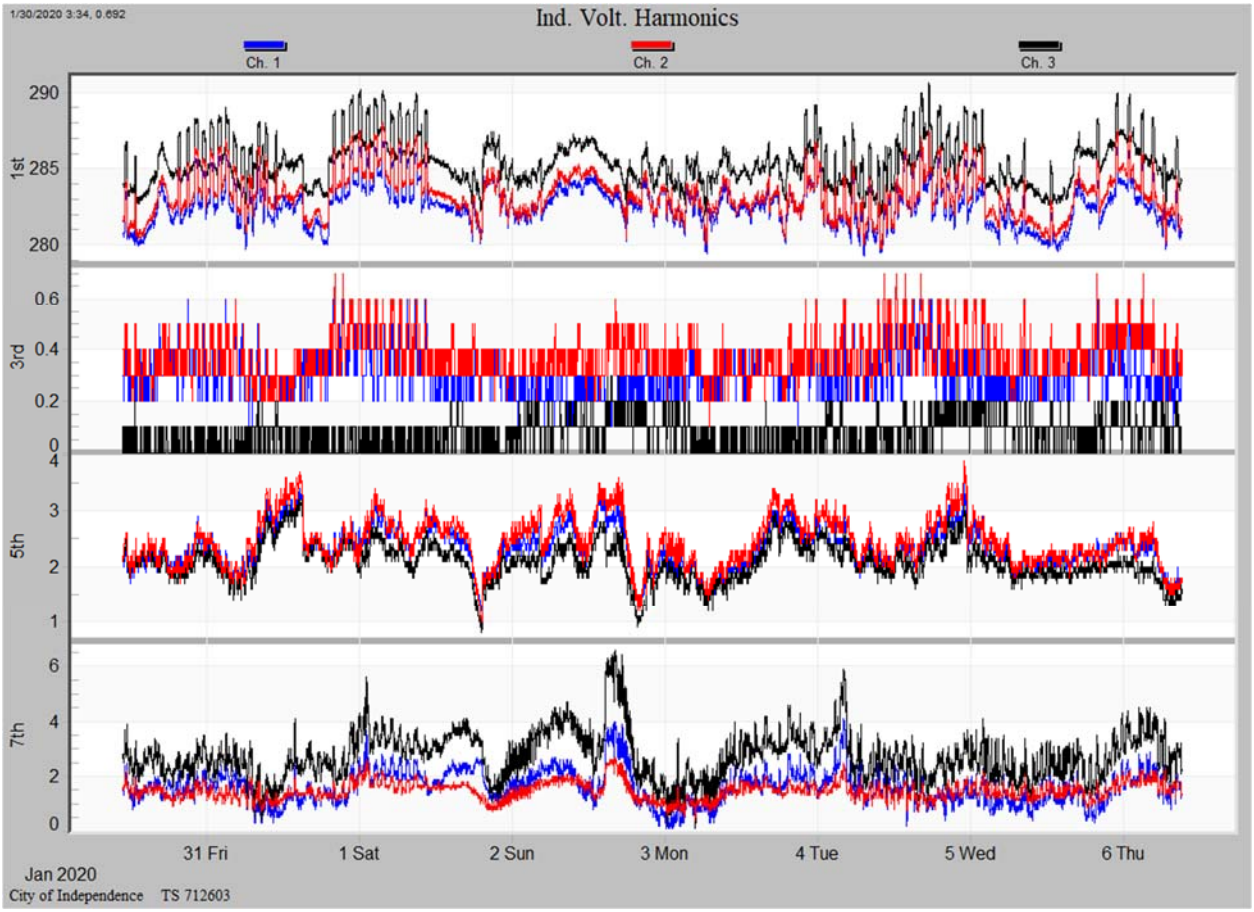

Figure 4: Voltage 1st (Fundamental), 3rd, 5th, and 7th Harmonics

Individual Current Harmonics

Figure 5 is the breakdown of current harmonic content. Most harmonic content present is the 5th.

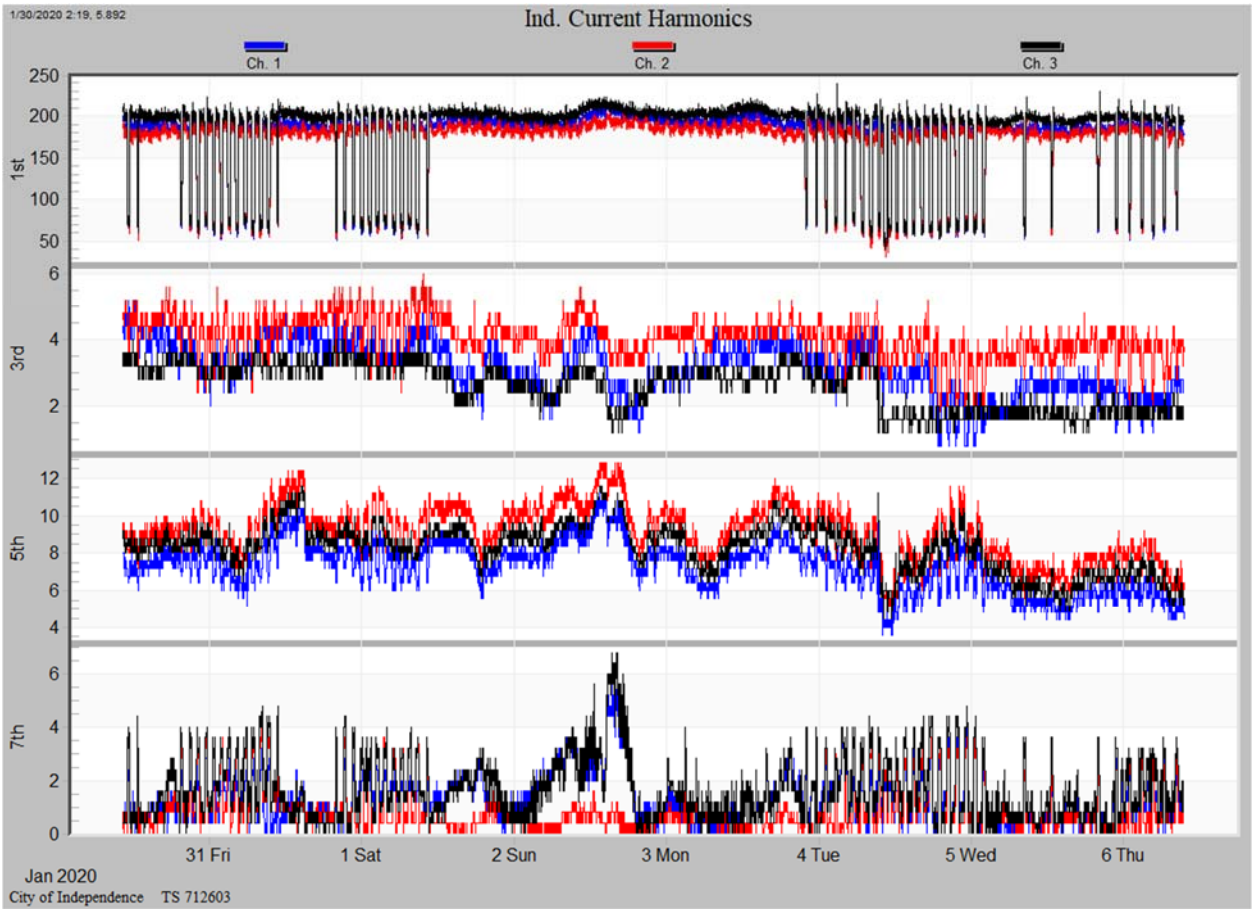

Figure 5: Current 1st (Fundamental), 3rd, 5th, and 7th Harmonics

Voltage Distortion Limits

Bus voltage V at PCC	Individual harmonic (%)	Total harmonic distortion THD (%)
$V \leq 1.0$ kV	5.0	8.0
1 kV $< V \leq 69$ kV	3.0	5.0
69 kV $< V \leq 161$ kV	1.5	2.5
161 kV $< V$	1.0	1.5[a]

Figure 6: IEEE Standard 519

Conclusion

- The City of Independence had a power factor between .65 and .9 during this period at TS 712603.
- Evergy penalizes on a power factor below 0.9 or 90%.
- To maintain a Power Factor greater than or equal to 90% (0.9) the customer would need to add at least 85 KVAR of capacitance, whether it be static or variable.
- The customer's load can vary and a KVAR value greater than those suggested above might be required to maintain a power factor greater than 90%.
- The customer should seek the services from an engineering consulting firm to assist with sizing of power factor correction capacitors and/or a harmonic filter.
- Additional current harmonic analysis may be needed in order to fully interpret the current harmonics. This additional analysis could assist with the design of a harmonic filter if needed.
- Evergy will be willing to provide the consultant with any of the load data that has been collected to date.

Completed by: Daniel Gilchrist, Engineer, *Distribution System Engineering*

**The values discussed in this analysis are valid only for the time period monitored and will change depending on the time of year, facility operation, and configuration. Values are for Evergy customer's informational use only, and do not represent any guarantee or warranty on the future values. The customer should use its own analysis or obtain an independent expert's assistance in the selection of equipment. **