Palo Verde Electricity Hub Analysis (2014-2024)

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Overview

The Intercontinental Exchange (ICE) has provided the U.S. Energy Information Administration selected wholesale daily spot price data from 2001-2024 (https://www.eia.gov/electricity/wholesale/) for 8 electricity hubs:

1. ERCOT North 345KV Peak

2. Indiana Rt Peak

3. Mid C Peak

4. Nepool MH DA LMP Peak

5. NP15 EZ Gen DA LMP Peak

6. Palo Verde Peak

7. PJM WH Real Time Peak

8. SP-15 Gen DA LMP Peak

This report has analyzed the past 10 years of daily spot price data for Palo Verde Peak and discovered that daily

Code

```
# Import libraries
library(readxl)
library(dplyr)
library(ggplot2)
```

```
# Import weather data
weather_data <- read.csv ("./Data/phx_weather_2021.csv")
```

```r
data_2014 <- read_excel ("./Data/ice_electric-2014final.xls")

# Need to correct "Nepool MH Da LMP Peak" to "Nepool MH DA LMP Peak"
# Need to correct "NP 15 EZ..." to "NP15 EZ Gen..."
# Correct "Palo Verde" to "Palo Verde Peak"
# Change "SP-15 Gen DA LMP Peak" to "SP15 EZ Gen DA LMP Peak"
colnames(data_2014) <- gsub("\n", " ", colnames(data_2014))
colnames(data_2014) <- gsub("  ", " ", colnames(data_2014))

data_2014 <- data_2014 %>%
  mutate(`Price hub` =
          ifelse(`Price hub` == "Nepool MH Da LMP Peak", "Nepool MH DA LMP Peak",
          ifelse(`Price hub` == "Indiana Hub RT Peak", "Indiana Rt Peak",
          ifelse(`Price hub` == "PJM-Wh Real Time Peak", "PJM WH Real Time Peak",
          ifelse(`Price hub` == "Mid Columbia Peak", "Mid C Peak",
          ifelse(`Price hub` == "PJM Wh Real Time Peak", "PJM WH Real Time Peak",
          ifelse(`Price hub` == "NP 15 EZ Gen DA LMP Peak", "NP15 EZ Gen DA LMP Peak",
          ifelse(`Price hub` == "Palo Verde", "Palo Verde Peak",
          ifelse(`Price hub` == "SP15 EZ Gen DA LMP Peak", "SP-15 Gen DA LMP Peak", `Price hub`))))))))

data_2015 <- read_excel ("./Data/ice_electric-2015final.xls")
colnames(data_2015) <- gsub("\n", " ", colnames(data_2015))
colnames(data_2015) <- gsub("  ", " ", colnames(data_2015))
unique(c(colnames(data_2015)))
data_2015

data_2016 <- read_excel ("./Data/ice_electric-2016final.xls")
colnames(data_2016) <- gsub("\n", " ", colnames(data_2016))
colnames(data_2016) <- gsub("  ", " ", colnames(data_2016))
unique(c(colnames(data_2016)))
data_2016

data_2017 <- read_excel ("./Data/ice_electric-2017final.xlsx")
colnames(data_2017) <- gsub("\r\n", " ", colnames(data_2017))
colnames(data_2017) <- gsub("  ", " ", colnames(data_2017))
unique(c(colnames(data_2017)))
data_2017

data_2018 <- read_excel ("./Data/ice_electric-2018final.xlsx")
colnames(data_2018) <- gsub("\r\n", " ", colnames(data_2018))
colnames(data_2018) <- gsub("  ", " ", colnames(data_2018))
unique(c(colnames(data_2018)))
data_2018

data_2019 <- read_excel ("./Data/ice_electric-2019final.xlsx")
colnames(data_2019) <- gsub("\r\n", " ", colnames(data_2019))
colnames(data_2019) <- gsub("  ", " ", colnames(data_2019))
unique(c(colnames(data_2019)))
data_2019

data_2020 <- read_excel ("./Data/ice_electric-2020final.xlsx")
colnames(data_2020) <- gsub("\r\n", " ", colnames(data_2020))
colnames(data_2020) <- gsub("  ", " ", colnames(data_2020))
```

```
unique(c(colnames(data_2020)))
data_2020

data_2021 <- read_excel ("./Data/ice_electric-2021final.xlsx")
colnames(data_2021) <- gsub("\r\n", " ", colnames(data_2021))
colnames(data_2021) <- gsub("  ", " ", colnames(data_2021))
unique(c(colnames(data_2021)))
data_2021

data_2022 <- read_excel ("./Data/ice_electric-2022final.xlsx")
data_2022 <- select(data_2022, -'Trade date') # REMOVE COLUMN because it's bad
data_2022$'Trade date' <- data_2022$`Delivery start date` - 86400
data_2022 <- data_2022 %>% select(1, `Trade date`, everything()) # Make 'Trade date' the 2nd column lik
colnames(data_2022) <- gsub("\r\n", " ", colnames(data_2022))
colnames(data_2022) <- gsub("  ", " ", colnames(data_2022))
unique(c(colnames(data_2022)))
data_2022

data_2023 <- read_excel ("./Data/ice_electric-2023final.xlsx")
colnames(data_2023) <- gsub("\r\n", " ", colnames(data_2023))
colnames(data_2023) <- gsub("  ", " ", colnames(data_2023))
unique(c(colnames(data_2023)))
data_2023

data_2024 <- read_excel ("./Data/ice_electric-2024.xlsx")
colnames(data_2024) <- gsub("\r\n", " ", colnames(data_2024))
colnames(data_2024) <- gsub("  ", " ", colnames(data_2024))
unique(c(colnames(data_2024)))
data_2024
```

Head 2014-2024

Use the following to make mass changes:

```
# 8 Peaks (2014-2019):
#
# "ERCOT North 345KV Peak"
# "Indiana Rt Peak"
# "Mid C Peak"
# "Nepool MH DA LMP Peak"
# "NP15 EZ Gen DA LMP Peak"
# "Palo Verde Peak"
# "PJM WH Real Time Peak"
# "SP-15 Gen DA LMP Peak"

unique(data_2014$`Price hub`)
unique(data_2015$`Price hub`)
unique(data_2016$`Price hub`)
unique(data_2017$`Price hub`)
unique(data_2018$`Price hub`)
unique(data_2019$`Price hub`)
```

```r
# 7 Peaks (2020-2024):

# Indiana Hub RT Peak
# Mid C Peak
# Nepool MH DA LMP Peak
# NP15 EZ Gen DA LMP Peak
# Palo Verde Peak
# PJM WH Real Time Peak
# SP15 EZ Gen DA LMP Peak
#
# Missing is "ERCOT North 345KV Peak"

unique(data_2020$`Price hub`) # 7 Peaks
unique(data_2021$`Price hub`) # 7 Peaks
unique(data_2022$`Price hub`) # 7 Peaks
unique(data_2023$`Price hub`) # 7 Peaks
unique(data_2024$`Price hub`) # 7 Peaks
```

Combined Dataset

```r
combined_data <- rbind(data_2014, data_2015, data_2016, data_2017, data_2018, data_2019, data_2020, data
combined_data
```

```r
# Plot the data

# Make sure the dates are in the correct format
combined_data$`Trade date` <- as.Date(combined_data$`Trade date`)

# Filter dataset for "Palo Verde Peak"
palo_verde_peak <- combined_data %>% filter(`Price hub` == 'Palo Verde Peak')

# Rearrange "Change" column from largest to smallest
palo_verde_peak %>% arrange(desc(Change))

# Look at top results
head(palo_verde_peak)
# Top 6 trade dates are:
# 2021-06-16
# 2020-08-17
# 2023-08-15
# 2022-09-05
# 2022-08-31
# 2020-09-03

# Let's look at June 2021:
pvp_june_2021 <- palo_verde_peak %>%
  filter(`Trade date` > as.Date('2021-06-01') & `Trade date` < as.Date('2021-06-30'))
pvp_june_2021

ggplot(pvp_june_2021, aes(x = `Trade date`, y = Change)) +
  geom_line() +
```
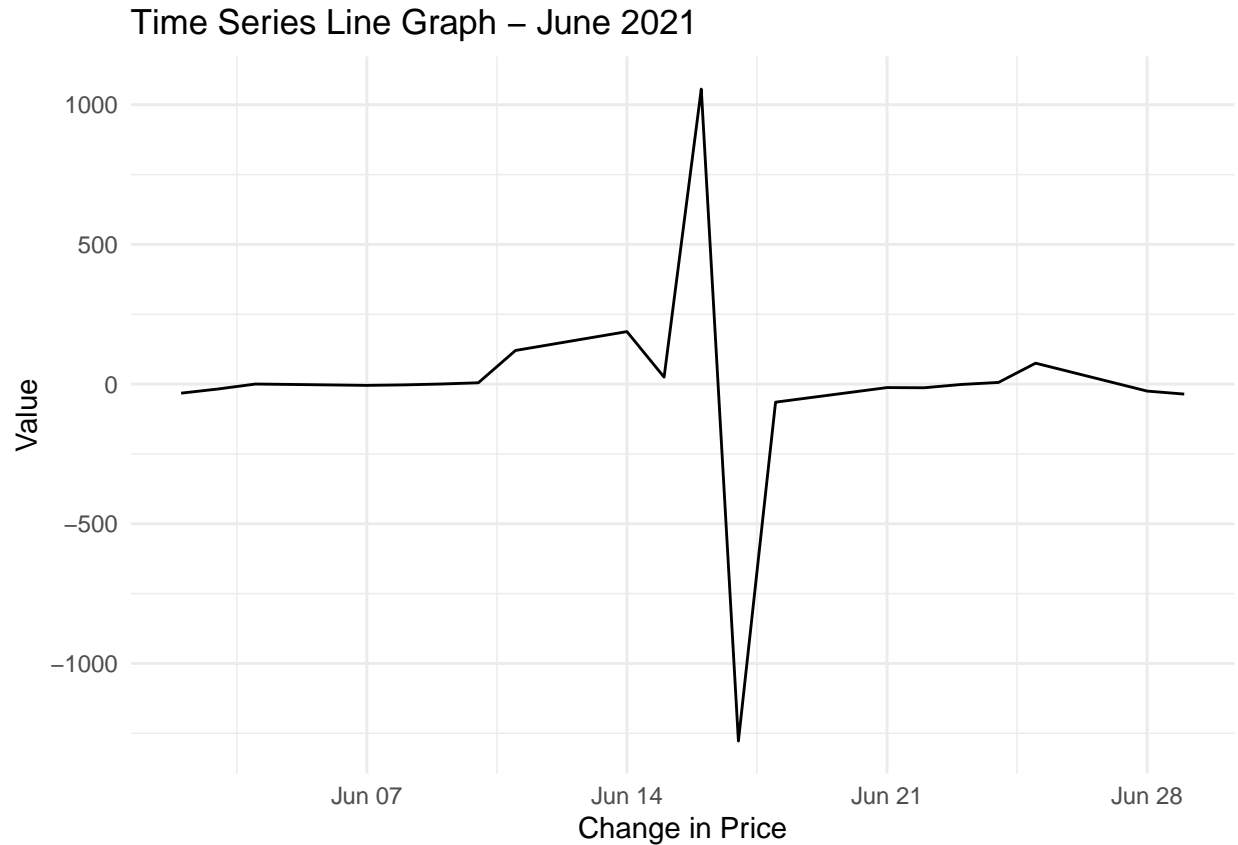
```
    labs(title = "Time Series Line Graph - June 2021",
         x = "Change in Price",
         y = "Value") +
  theme_minimal()
```

Time Series Line Graph – June 2021


```
# Let's look at August & September 2020:
pvp_aug_2020 <- palo_verde_peak %>%
  filter(`Trade date` > as.Date('2020-08-01') & `Trade date` < as.Date('2020-08-31'))
pvp_aug_2020

pvp_sept_2020 <- palo_verde_peak %>%
  filter(`Trade date` > as.Date('2020-09-01') & `Trade date` < as.Date('2020-09-30'))
pvp_sept_2020
```

Some additional factors to look at:

- $84 million in higher wholesale short-term sales primarily due to: (i) an increase in price and sales volume; and (ii) an increase in capacity sales to affiliates for a tolling PPA (Power Purchase Agreement) entered into in June 2021; (https://www.sec.gov/ix?doc=/Archives/edgar/data/100122/000010012222000020/tep-20211231.htm)

Import Weather Dataset

Fixing Hidden Characters in Columns

```r
# This showed me that there were hidden columns

unique(c(colnames(data_2014))) # "Delivery \nend date"
unique(c(colnames(data_2015))) # "Delivery \nend date"
unique(c(colnames(data_2016))) # "Delivery \nend date"
unique(c(colnames(data_2017))) # "Delivery \r\nend date"
unique(c(colnames(data_2018))) # "Delivery \r\nend date"
unique(c(colnames(data_2019))) # "Delivery \r\nend date"
unique(c(colnames(data_2020))) # "Delivery \r\nend date"
unique(c(colnames(data_2021))) # "Delivery \r\nend date"
unique(c(colnames(data_2022))) # "Delivery \r\nend date"
unique(c(colnames(data_2023))) # "Delivery \r\nend date"
unique(c(colnames(data_2024))) # "Delivery \r\nend date"
```