Bachelor’s Thesis

The Role of SAP Analytics Cloud Smart Predict Time Series Feature in Evaluating Energy Consumption Trends and Environmental Impact of the SAP Metronom Business Center Office Location

Academic Supervisor: prof. Ing. Martin Hanel, Ph.D.
Supervisor at SAP: Ing. Pavel Strnad
Author: Vera Vavan, SAP

2023

Czech University of Life Sciences Prague
Faculty of Environmental Sciences

Agenda

Thesis Objectives

- SAP Perspective
- Data Analysis Perspective

Research Methodology

- Data Wrangling
- Visualizations
- Forecasts

Results and Discussion

- Energy Consumption and CO2 Production
- Time Series Chart Forecast and Predictive Scenarios

Conclusions

Thesis Objectives

SAP Objectives

- Environmental impact of office buildings monitoring
- Data Democratization (DDEM) empowerment with SAP BTP solutions
- The chances of becoming carbon neutral in 2023

Data Analysis Objectives

- Investigating the energy consumption changes and their environmental impact in the context of COVID-19 shutdown in one of the Prague SAP offices
- Assessing the accuracy and reliability of smart predict forecast features in SAP Analytics Cloud

Research Methodology

Data Wrangling

- Data acquirement through the SAP Metronom Business Center landlord (White Star Real Estate) for the period between January 1, 2019 and March 31, 2022
- Importing the energy consumption data for the heating, cooling, water and electricity consumption into the SAC Modeler tool and editing the dataset semantic
- Data quality checks and calculations for the corresponding CO2 productions using the given emission factors:
  - 0.382/1000 for electricity
  - 0.055*1000 for cooling and heating
  - 0.00038*1000 for water

Research Methodology

Sensor	Sensor Type	Unit	Floor	Building	Location	TimeStampNew	Consumpption
2RSC.D_PW_23	electricity meter	Wh	2.NP	C	Bucharova 2817/11	1/1/2020 0:00	768
8RSB.D_PW_83	electricity meter	Wh	8.NP	B	Bucharova 2817/11	8/11/2021 11:00	140
8WM.B.67_160422517A	water meter	m3	8.NP	B	Bucharova 2817/11	10/23/2021 23:00	0
2WM.A.33_16210433	water meter	m3	2.NP	A	Bucharova 2817/11	8/16/2020 1:00	2.66
5CM.B.1_51722749	calorimeter cooling	GJ	5.NP	B	Bucharova 2817/11	1/7/2022 14:00	0
9CM.A.1_62016499	calorimeter cooling	GJ	9.NP	A	Bucharova 2817/11	3/25/2020 23:00	0.09
9HM.B.1_53872591	calorimeter heating	GJ	9.NP	B	Bucharova 2817/11	1/25/2022 16:00	0.11
6HM.C.1_61107075	calorimeter heating	GJ	6.NP	C	Bucharova 2817/11	1/27/2022 19:00	0.1

Table 1: Data Sample of 8 Rows for the Provided CSV data

Research Methodology

Visualizations

- Creation of two pages using the SAC Story tool, one focused on energy consumption and one on CO2 production
- Finding the individual consumptions/productions per variable for each year and finding their variance compared to the previous year
- Producing time series charts, separating the consumption/production per variable for different buildings (A, B and C)

Research Methodology

Forecasts

- Applying the time series chart forecast functionality to CO2 production visualizations in SAC Story on each variable (heating, cooling, electricity, water and total production)
- Training a predictive model using the Predictive Scenario tool in SAC, with the target variable being consumption separated by the sensor types and suppressing negative values

  - Forecast periods: 92
  - Predicted date range: April 1, 2022 until July 1, 2022

Results and Discussion

Figure 1: Energy Consumption SAC Story Page (Cooling and Heating)

Results and Discussion

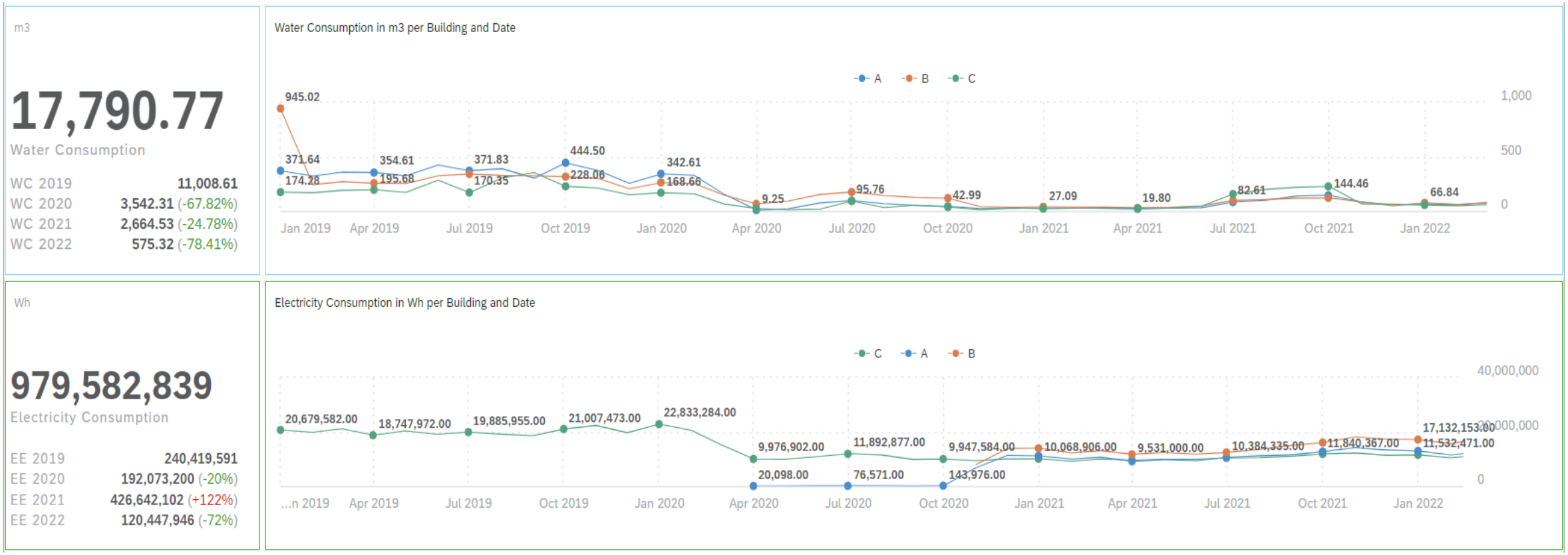


Figure 2: Energy Consumption SAC Story Page (Water and Electricity)

Results and Discussion – Energy Consumption

- Negative trend for cooling and water consumption kept over the years
- Slight increase in cooling, attributed to the catch-up effect and low temperatures
- High increase in electricity, connected to the missing sensor data before 2021
- High seasonal changes for cooling and heating, steady trend for electricity and slight yearly trend for water consumption with an increase between June and October
- Highest usage in building B, followed by building A
- Overall, the consumption is lower than the pre-pandemic level

Results and Discussion

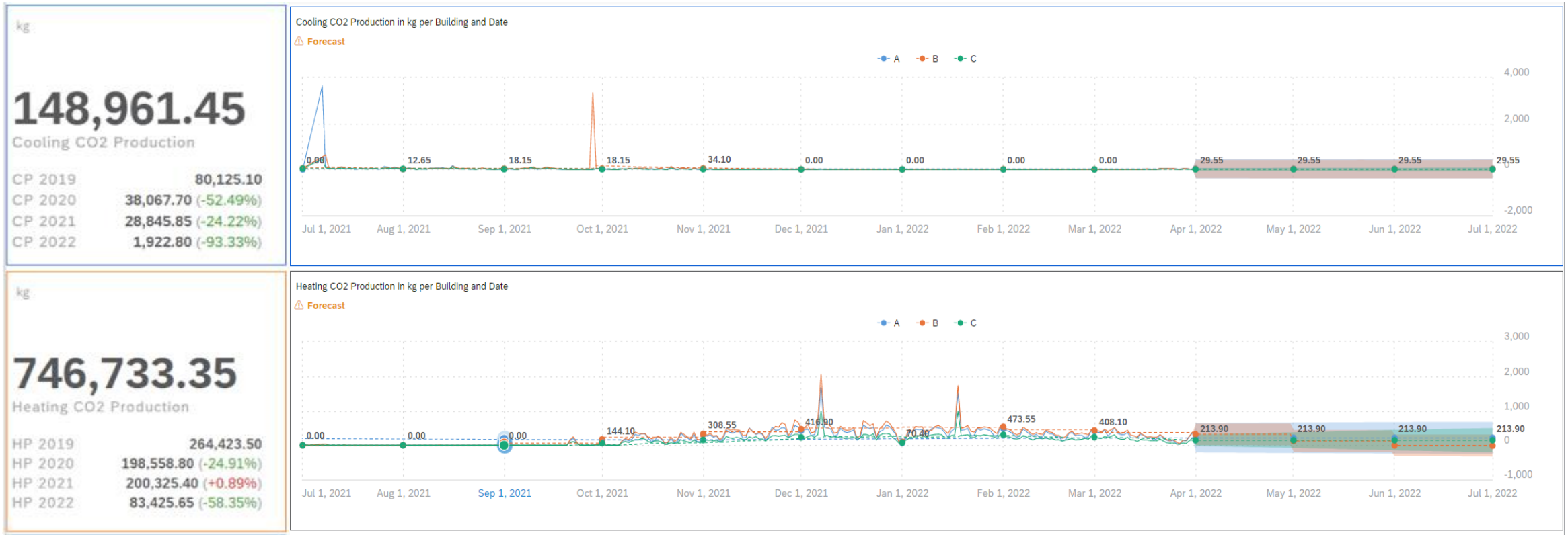


Figure 3: CO2 Production SAC Story Page with Time Series Chart Forecasting (Cooling and Heating)

Results and Discussion

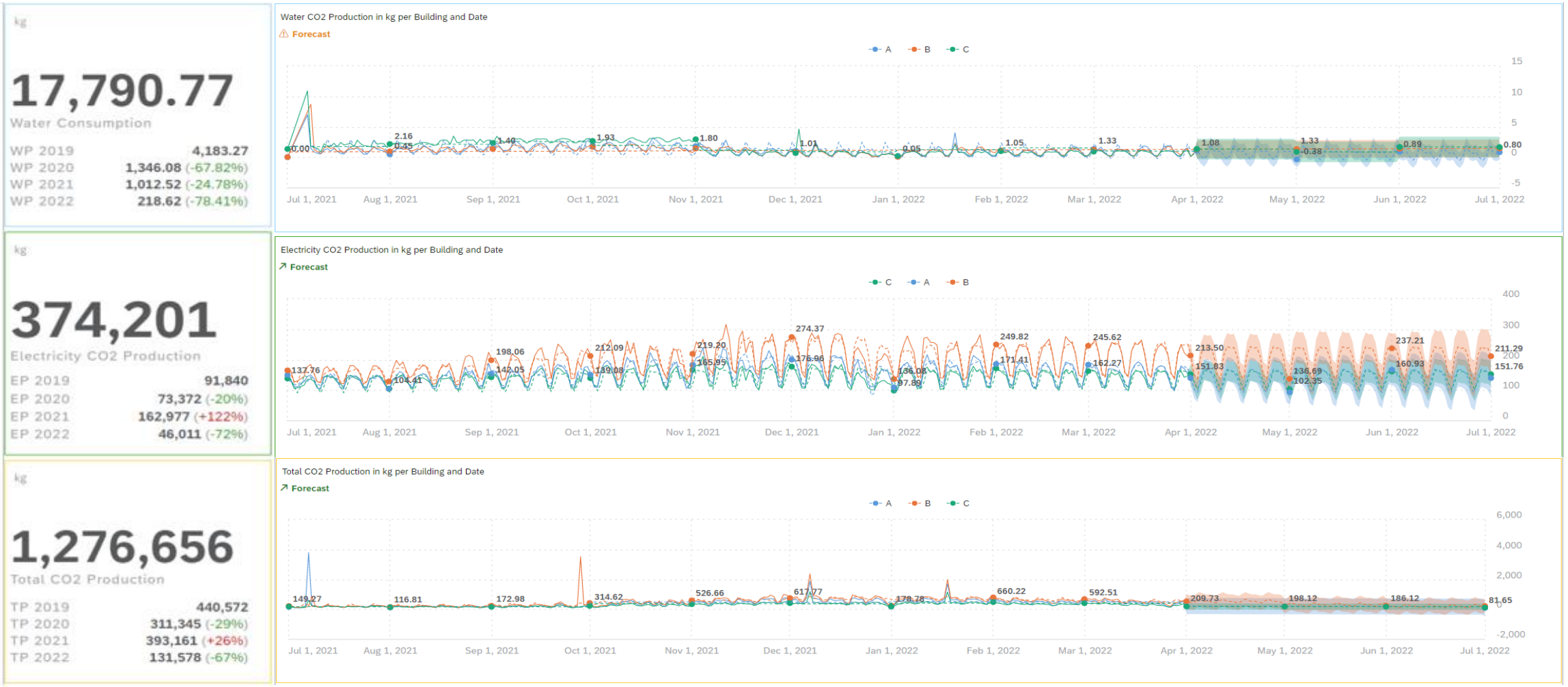


Figure 4: CO2 Production SAC Story Page with Time Series Chart Forecasting (Water, Electricity and Total)

Results and Discussion – CO2 Production Forecast

- Direct relation of CO2 production to energy consumption, but the units are the same (kg)
- Low confidence in heating, cooling and water consumption
- Highest confidence in electricity consumption where the weekly patterns are recognized
- Total CO2 production heavily influenced by heating consumption
- Decreasing trends interpreted as future negative values, making the predictions unrealistic
- The tool is easy to use and interpret

Results and Discussion

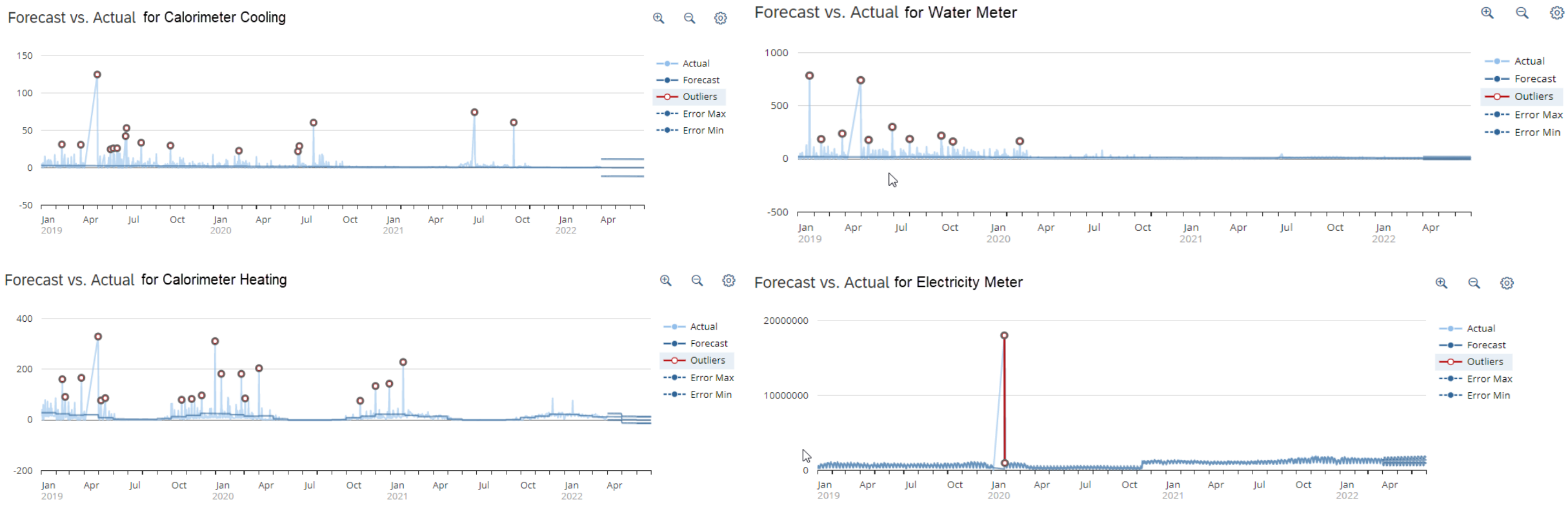
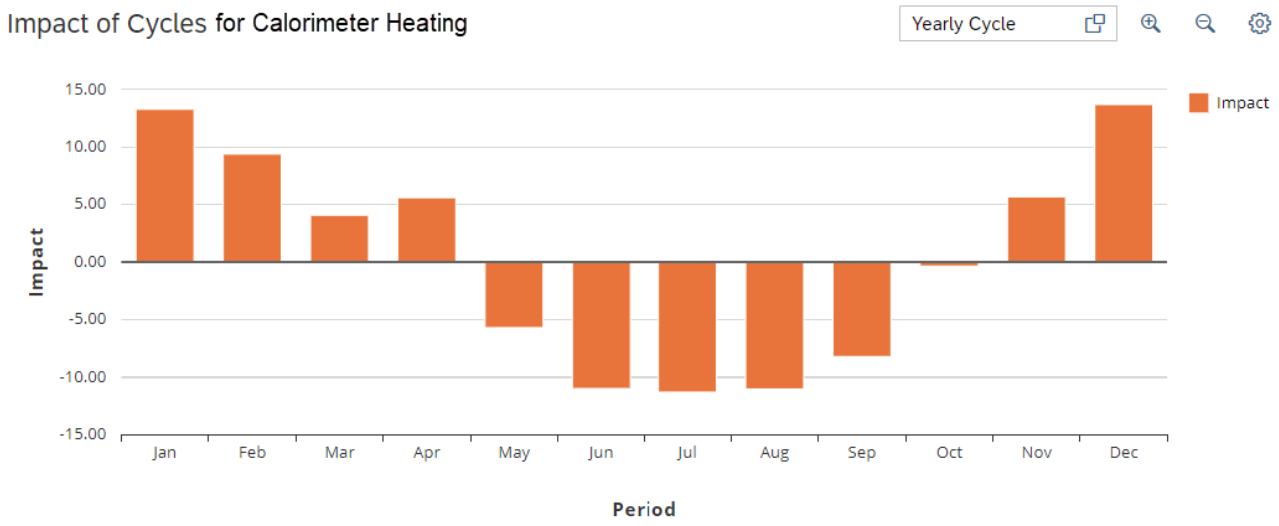


Figure 5: Predictive Scenario Charts for Cooling, Heating, Water and Electricity

Results and Discussion



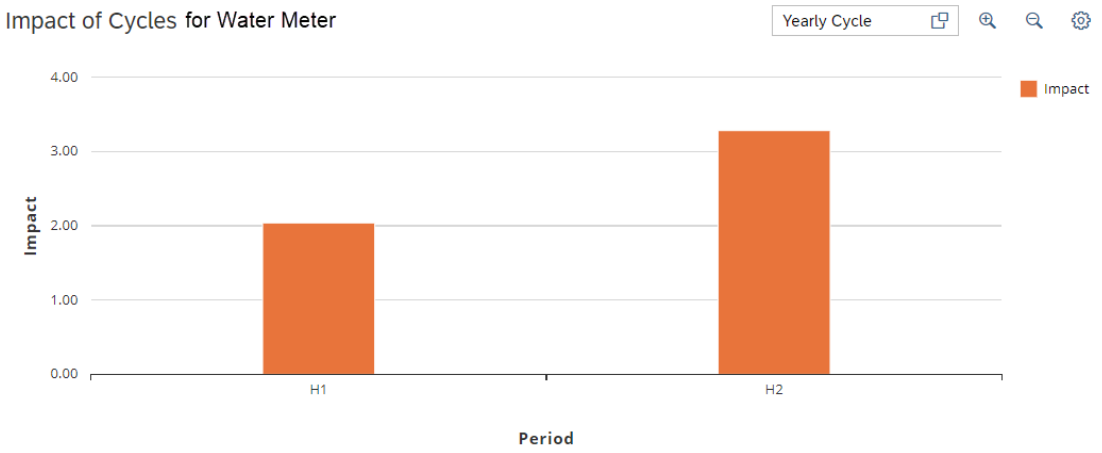


Figure 6: Predictive Scenario Cycle Impact for Heating and Water Consumption

Results and Discussion – Energy Consumption Responsibility Scenario

- MAPE median expected value of 193.15% and the MAPE average of 163.36%
- MAPE 12.13% for electricity, 131.15% for water, 254.79% for cooling and 255.01% for heating
- No negative values, only confidence intervals which are quite large
- Poor weekly trend recognition, resulting in bad data fittings for the prediction model and high MAPE
- Yearly trend recognized only for heating and water consumption, and the impact is low
- Limited results insights and personalization
- Missing data and COVID-19 shutdown not impacting results

Results and Discussion

- General negative trend is recognized in comparison to 2019, with a catch-up effect only in heating and electricity consumption, due to employee preference of the remote working model
- Limited information due to missing and restricted data which also affects CO2 production
- Poor confidence and prediction reliability due to scarce personalization options and weekly pattern recognition inconsistencies
- Easy to use, however, addition of data insights and data semantic options would increase reliability and data-driven decision making
- Metronom Business Center implements energy usage restrictions based on occupacy

Conclusions

- Overall, historical data shows a negative trend in consumption with a slight catch-up effect which is not higher than the consumption before COVID-19
- Highest influence on CO2 production is from heating consumption, hence implementing new policies and investing in greener energy sources can help SAP become carbon neutral
- Future predictions have low confidence in most variables due to poor recognition of daily patterns, but the trend seems to be decreasing on a higher monthly scale
- While both tools empower DDEM, Predictive Scenarios are more accurate but time series chart forecasts are easier to use, which can result in ill-informed user misinterpreting data
- Including data insights and suggestion can highly improve user experience and DDEM

Thank you.