ENERGY MANAGEMENT SYSTEM

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BACKGROUND

- Coca-Cola Southwest Beverages, a company of Arca Continental, is one of the largest Coca-Cola bottlers in the United States and Latin America.
- Coca-Cola is aiming to reduce their carbon footprint, increment recycling and incorporate sustainability in every action they take.
- Coca-Cola will take care to know the consumption of energy and water to manage the consumption levels of productions.
PROBLEM STATEMENT

• Coca-Cola needs to understand where water and energy is being used and where they could improve consumption levels.
• Control limits need to be established to standardize a consumption optimization process.
PRODUCTION PROCESS

Syrup room

Filler
PRODUCTION PROCESS CONT.
WATER SENSOR LOCATIONS
ENERGY SENSOR LOCATIONS
ENERGY USE RATIO (EUR)

Environmental Metric – EUR

EUR 2023 Goal 0.281 vs YTD = .256
WATER USE RATIO (WUR)

**Environmental Metric – WUR**

**Water Use Ratio**

<table>
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<tr>
<th>Metric</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
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<th>September</th>
<th>October</th>
<th>November</th>
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<td>YTD</td>
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<td>1.553</td>
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WUR 2023 Goal = 1.53 vs YTD = 1.533
OBJECTIVES

Identify
- Identify out of control areas within the production lines

Implement
- Implement Energy Management System to track daily water consumption

Standardize
- Standardize water use in production lines and minimize water consumption to approximate the WUR
METHODOLOGY

To reduce the energy and water consumption of the facility through the application of Six Sigma principles by generating the Control Limits per shift in accordance with the fast-paced changing demand.

It is desired to Implement an Energy Management System that will help Arca Continental to monitor the energy consumption and demand.
## Energy Management System

**Sponsor:** Emmanuel Juarez  
**Team:** Abraham Ambroz / Juan M. Barrera  
**Date:** 01/01/2023  
**Rev:** 1

### Future Condition
- **What would we like things to look like in the future?**
- Achieve 2023 WJIR and EUIR goals and establish routines to monitor and improve water and energy by using the Energy Management System.

### Implementation Plan
- A list of major steps required to complete the project.

<table>
<thead>
<tr>
<th>ID</th>
<th>Activities</th>
<th>Resp. (DATE)</th>
<th>Schedule</th>
<th>Comments</th>
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<td>1</td>
<td>Data Accuracy</td>
<td>Juan B.</td>
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<td>2</td>
<td>Meeting with UTEP Students</td>
<td>Juan B.</td>
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<td>3</td>
<td>Managers and Students Training</td>
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<td>4</td>
<td>Plant tour with UTEP Students and include new CI Lead (ELP)</td>
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<td>5</td>
<td>Start weekly routine to analyze data and reports (every Tuesday before Staff)</td>
<td>Juan B.</td>
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<td>6</td>
<td>Remove and send Gas Meters to calibrate (Warmers)</td>
<td>Buildtech</td>
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<td>7</td>
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<td>Abraham A.</td>
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<td>8</td>
<td>Gas Meters Re-Install</td>
<td>Buildtech</td>
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<td>9</td>
<td>Filter Meter data validation</td>
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<td>Rename Sensors and add description</td>
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<td>11</td>
<td>New Breaker for Electric sensors</td>
<td>ELP</td>
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<td>12</td>
<td>Electric meters not providing data (investigate why)</td>
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<td>13</td>
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<td>14</td>
<td>Set up Alarms</td>
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<td>15</td>
<td>Create Control Limits</td>
<td>Buildtech B.</td>
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<td></td>
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<td>16</td>
<td>Set up Alarms with results of the Control Limits</td>
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<td>Meeting with Coca-Cola Corporation</td>
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<td>18</td>
<td>Tools/Reports</td>
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<td>19</td>
<td>Provide email address to set up alerts</td>
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<td>Use Ecoreports and dashboards during weekly meeting</td>
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<td>22</td>
<td>MiniTab results</td>
<td>UTEP</td>
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### Notes
- Sensor installation pending
ENERGY MANAGEMENT SYSTEM

1. ENERGY MANAGEMENT SYSTEM
1.1 CENTRAL MONITORING SYSTEM EQUIPMENT

PROPOSAL

1.1 Central Monitoring System Equipment

- 1 N4 Supervisor Software
- 1 Five Year Software Maintenance Agreement
- 1 License for 250 analytic points for a N4 Supervisor
- WEB-8000 base controller plus 8100 160 Device / 5,000 Point Core for N4.
- 2 Five Year Software Maintenance Agreement for 8100 Core

ETHETERN
FIELD BUS MODBUS OR BACNET MS/TP
INTERNET

PROPOSER:
Energy Management System

RECEIVER:
ARCAS SOUTHWEST BEVERAGES
Engineering Department

DATE:
9/15/2021

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GAS, ELECTRICITY, AND WATER SENSORS
DATA COLLECTION

Water Sensors

EcoReports
WATER SENSORS

- Electromagnetic sensors
- Ultrasonic sensor
EcoReports dashboards retrieve information from the i-Vu Pro building automation system and provide intelligent and informative views for facility managers.

Export the trend source data on a periodic basis from meters. Create graphs, charts, reports and dashboards to visualize building data easily.
DATA CLEANSING

Identify Data

- Fix Structural Mistakes
- Set Data Cleaning Techniques
- Filter Outliers and Fix Missing Data
- Repeat the Process
DATA VALIDATION AND ANALYSIS

Shift 1
- 5:00 AM – 1:00 PM
  - Main Water Meter
  - Condenser
  - Water Treatment
  - Facility
  - Filler Line 1 & 2
  - Warmer Line 1 & 2
  - Sanitation Line 1 & 2

Shift 2
- 1:00 PM – 9:00 PM
  - Main Water
  - Condenser
  - Water Treatment
  - Facility
  - Filler Line 1 & 2
  - Warmer Line 1 & 2
  - Sanitation Line 1 & 2

Shift 3
- 9:00 PM – 5:00 AM
  - Main Water
  - Condenser
  - Water Treatment
  - Facility
  - Filler Line 1 & 2
  - Warmer Line 1 & 2
  - Sanitation Line 1 & 2
MINITAB WORK PROCESS

1. Control limits for Main Water Meter
   Condenser
   Water Treatment Facility

2. Control limits for Production Line 1 Meter
   Filler Can
   Warmer Can
   Sanitation Can

3. Control limits for Production Line 2 Meter
   Filler Can
   Warmer Can
   Sanitation Can
CONTROL LIMITS MAIN WATER METER

Condenser

Water Treatment

Facility

90%
CONTROL LIMITS

IM-R Control Charts Per Shift Per Day

One-Way ANOVA: Shift vs Day

Control Charts Per Shift Per Group
I-MR Chart of Shift 2

Calculations: 17, 53, 67

I-MR Chart of Shift 1

I-MR Chart of Shift 3

IM-R CONTROL CHARTS PER SHIFT PER DAY
ONE-WAY ANOVA: SHIFT VS DAY

Analysis of Variance

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<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Adj SS</th>
<th>Adj MS</th>
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Grouping Information Using the Fisher LSD Method and 95% Confidence

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<thead>
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<th>Day</th>
<th>N</th>
<th>Mean</th>
<th>Confidence</th>
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<tr>
<td>W</td>
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<td>98786</td>
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<td>TR</td>
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<td>90496</td>
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<td>T</td>
<td>9</td>
<td>88064</td>
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<td>B</td>
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<td>M</td>
<td>7</td>
<td>77653</td>
<td>A</td>
<td>B</td>
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<tr>
<td>F</td>
<td>9</td>
<td>69033</td>
<td>B</td>
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</tr>
<tr>
<td>SU</td>
<td>8</td>
<td>19469</td>
<td>C</td>
<td></td>
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<tr>
<td>S</td>
<td>8</td>
<td>18128</td>
<td>C</td>
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Means that do not share a letter are significantly different.
MAIN WATER METER

Shift 1
- Group A: 131341
- Group B: 140539
- Group C: 64674

Shift 2
- Group A: 138996
- Group B: 169111
- Group C: 111828

Shift 3
- Group A: 126916
- Group B: 19393
- Group C: 72468

Units: Gallons of water per shift
CONTROL LIMITS PRODUCTION LINE 1

- Filler Can
- Warmer Can
- Sanitation Can
FILLER CAN

Units: Gallons of water per shift

Shift 1
- Group A: 7183
  - M, T, W, TR, F
- Group B: 6488
  - S, SU

Shift 2
- Group A: 1360
  - M, T, W, TR, F
- Group B: 20011
  - S, SU

Shift 3
- Group A: 6558
  - T, W, TR, F, S
- Group B: 19393
  - M, SU
A Culture of Growth

Units: Gallons of water per shift

Shift 1
Group A: 2616
M, T, W, TR, F, S, SU

Shift 2
Group A: 1904
M, W, TR
Group B: 318
T, F, S, SU

Shift 3
Group A: 7643
M
Group B: 2618
T, W, TR, F, S
Group C: 2460
SU
SANITATION CAN

Units: Gallons of water per shift

Shift 1
- Group A: 6578
  - M, S, SU
- Group B: 5155
  - W, F
- Group C: 3021
  - T, TR

Shift 2
- Group A: 7847
  - W, TR, F, SU
- Group B: 10131
  - M, T, S

Shift 3
- Group A: 6483
  - M, T, W, TR, F, S, SU
CONTROL LIMITS
PRODUCTION LINE 2

Filler Bottle
Warmer Bottle
Sanitation Bottle
FILLER BOTTLE

Units: Gallons of water per shift

Shift 1
- Group A: 751
  - M, F, SU
- Group B: 873
  - T, W, TR, S

Shift 2
- Group A: 590
  - M, T, W, TR, F, S, SU

Shift 3
- Group A: 223
  - M, T, W, TR
- Group B: 207
  - F, S, SU
WARMER BOTTLE

Units: Gallons of water per shift

Shift 1
Group A: 2355
M, T, W, TR, F, S, SU

Shift 2
Group A: 12831
SU
Group B: 195
M, T, W, TR, F, S

Shift 3
Group A: 10911
S, SU, M
Group B: 11484
T, W, TR, F
SANITATION BOTTLE

Shift 1
- Group A: 1601
  - W, F, S, SU
- Group B: 2063
  - M, T, TR

Shift 2
- Group A: 1577
  - T, TR, S, SU
- Group B: 1587
  - M, W, F

Shift 3
- Group A: 1846
  - S, SU, M
- Group B: 1706
  - T, W, TR, F

Units: Gallons of water per shift
RESULTS
Results showed a trend for excess water consumption during the weekends. If there is much water consumption during the weekends, the facility needs to compensate and increase the production during the week to achieve the water use ratio target.
Filler 1: it is working three shifts
Filler 2: it is working only two shifts
Therefore, water control limits are higher for filler 1
Filler Bottle / Last 30 days

0-26 gal  27-54 gal  55-81 gal  82-108 gal  >= 109 gal

A Culture of GROWTH
WARMER CAN LINE 1

Warm Can / Last 30 days

- 0-193 gal
- 194-382 gal
- 383-574 gal
- 575-955 gal
- >= 956 gal

Time intervals from 12:00 AM to 11:00 PM for April.
Sanitation process is the same for both production lines; however, results showed a significant increase in production line 1.
NEXT STEPS / RECOMMENDATIONS

• Monitoring control limits at the end of each shift needs to continue in order to gather more data, since this project was done during spring there is no knowledge of how temperature might affect water consumption
• With enough data it is easier to identify causes for out-of-control points, such as weekends and look for justifiable causes
• This project lays the groundwork for other sustainability efforts for electricity, gas, waste, etc.
• Investigate sanitation process to understand difference between production lines
• Look for ways to monitor week-end production cleaning
• Implement the alarm system to monitor the water and energy consumption of the facility
• Check for any gaps in data or inaccuracies that may depict damaged sensors or wrong data
5 WHY’S DIAGRAM

Problem: There are out of control points

WHY? Water superseded limits imposed

WHY? Too much water was used during a small amount of time

WHY? Water was used by production/sanitation at unusual rate

WHY? Human negligence/faulty machine

WHY? Incomplete inspection/supervision of factory area

Root Cause
There is prone to be higher water usage which will be out of control and will waste money for CCSWB.

**Equipment/Supply Factors (Availability, Working Order, Quality):**
1. Leaks in machines
2. Outdated hardware/hoses
3. Faulty machinery

**Environmental Factors (Location, Layout, Safety):**
1. Summer heat due to desert climate
2. Process is temperature based
3. Extensive cleaning process for safety

**Rules and Policies:**
1. Common to wash more than once
2. Routine weekends cleaning
3. Policies are not water conscious

**Staff:**
1. Staff may leave sanitation hoses on
2. Staff may not have water consciousness
3. Wastewater due to negligence
CONCLUSION

- Control limits were implemented in the energy management system.
- It will be possible to have greater control of water consumption in the facility.
- The control limits will be used to set an alarm system.
- The alarms will help to have better management in production lines.
- Managers will be able to monitor employee’s activities.
- Managers will be able to reach their desired water use ratio at the end of the year.
ABET LEARNING OUTCOMES

ABET 2: Engineering design was applied to the Senior Design Project by the use A3, 5 Why’s, and Fishbone diagrams to meet the Coca-Cola requirements of implementing an Energy Management System which poses an environmental matter to El Paso Community. Generation of Control Chart and the identification of patterns that showed controlled and randomized data.

ABET 3: The team communicated effectively complex Industrial and System engineering concepts to a large audience of students and processors at the EPCC Valle Verde location.

ABET 5: The students were able to create a team with each other as well as present ideas and have meetings with business professionals from both Coca-Cola as well as Buildtech, students presented leadership and proper communication qualities.

ABET 7: The senior design project included both previous knowledge and new knowledge for students. All students were completely unfamiliar with the processes Coca-Cola