P&G's Central Plant Optimization Program

REBUILD Conference – Oct 7, 2021
Chris Depenhart
Sales Executive, Siemens Smart Infrastructure

Mr. Depenhart manages key account relationships for Siemens Smart Infrastructure in the Life Sciences and Higher Education markets, including Procter & Gamble/Jones Long Lasalle account for North America
Panel Members

Steve Winbigler
Global Technical Leader – Utilities Systems
P&G Corporate Offices & Innovation Centers


Steve Weyler
JLL Engineering Director
JLL, a P&G GBS Business Partner

Responsible for providing technical support and guidance to JLL facility and project delivery teams servicing Procter & Gamble’s global portfolio. Define process and technology solutions to ensure safe, efficient and effective operations focusing on system reliability and total cost of ownership. Additional responsibilities include energy, sustainability and HS&E.
Panel Members

Jerome (Jerry) W. Doerger  
P.E. LEED AP, SPM  
Executive Vice President & Workplace Market Leader  
PEDCO E&A Services Inc.

Jerry is a Mechanical Engineer who has spent the past 32 years PEDCO. Responsibilities include client manager for PEDCO on the P&G account, overseeing PEDCO’s MEP designs for P&G. Throughout my career my technical responsibilities ranged from small engineering studies to commissioning of all the MEP systems at the Mason Business Center to the design of complex research laboratories, office buildings and central utility plants; totaling more than 3.5 million square feet.

David Eslinger, CEM  
Senior Energy Engineer, Atlantic Zone  
Siemens Smart Infrastructure

Responsible for optimizing chilled water and air-handling systems at Siemens building automation system customer sites.
Discussion Outline

1. P&G Net Zero Ambitions and facility operations
2. Why chilled water optimization?
3. Project approach and results
4. Operating and design philosophy in new work reality
These five megatrends are impacting us all

**55 billion**
The number of devices that will be linked online by 2020

**9.7 billion**
The earth’s population in 2050, with an average life expectancy of 83 years

**800,000 years ago**
The last time the Earth’s atmosphere had a higher CO₂ concentration

**70%**
The percentage of the population that will live in cities by 2050

**200%**
The growth rate of global trade between 2000 and 2014

P&G’s Ambition to Net Zero

Including 2030 science-based targets for Scope 1, 2,
and 3 emissions to accelerate progress.

2010

Path to Net Zero by 2040

Reduced operations emissions 52%*  
Reduced truck miles 25% per unit of production  
Avoided 200,000+ tons of plastic through package redesign

2021

Operations

Reduced operations emissions 52%*

Reduce absolute emissions as much as possible via energy efficiency and renewable energy

Pilot and scale renewable thermal energy solutions

Advance natural climate solutions to balance any emissions we cannot eliminate this decade

2030

Our Ambition

Net Zero

Across operations and supply chain emissions — from raw material to retailer

Cut most of our emissions

Balance any remaining emissions that cannot be eliminated with natural or technical solutions that remove and store carbon

2040

Additional Progress via our climate transition action plan

Reducing Operations

Avoided 30 million tons of water washing by 2030

Reducing Product Innovation

100% recycled or reusable packaging by 2030

Reducing Product End of Life

Enable more recycling in homes and communities

Pilot and scale materials from recycled carbon

*Against a 2010 baseline.
*Against a 2020 baseline.
*Inclusive of priority categories that account for over 90% of P&G’s supply chain emissions.
Why Focus on Building Energy Consumption?

They consume 40% of all energy

They use 25% of all water

They emit 33% of all greenhouse gases

Chilled Water Optimization Projects at Three P&G Facilities

**Winton Hills Business Center (WHBC)**
Four chillers (6,500 tons) serving 1.4M sq.ft.* of office, laboratory and production space

*WHBC since reduced to 1.1M sq.ft.

**General Offices (GO-Headquarters)**
Seven chillers (3,800 tons), serving 1.5M sq.ft. of office space.

**Mason Business Center (MBC)**
Seven chillers (14,300 tons) serving 2.2M sq.ft. of office, laboratory and production space

**General Offices**
- Headquarters showcase for P&G
- Member of Cincinnati 2030 District
- Two buildings, two plants and seven chillers
- Chilled water plant in good condition
Chilled Water Optimization Project – Scope at GO

Challenge #1: Complexity
• Two plants interconnected by cross-over piping
• Central Bldg plant (Four 650-ton centrifugal chillers)
• Tower Bldg plant (Two 500-ton centrifugal chillers, plus one 225-ton heat recovery chiller)
• Chilled water needed 365 days/year with nighttime and seasonal variability
• Primary chilled water pumping configuration limits flexibility

Challenge #2: “Always been done that way”
• Chiller sequencing handled manually, varied depending on operator on-duty
• No measurement of which chillers or plant was more efficient

Project Scope
• Added VFDs to 125-hp condenser water pumps in Central Bldg Plant
• Upgraded select temperature and pressure sensors to better measure flow and load at each chiller
• Automated isolation valves on older cooling tower
• Added VFDs to smaller booster pumps for CHW/HW 2-pipe loop
## Chilled Water Optimization Strategy

<table>
<thead>
<tr>
<th>Typical Characteristics</th>
<th>Inherent Shortcomings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chillers not operating at design temperature splits</td>
<td>&quot;Low Delta-T Syndrome&quot; hurts efficiency</td>
</tr>
<tr>
<td>Constant volume pumping of condenser water</td>
<td>Excessive pump energy, pump wear and chiller efficiency</td>
</tr>
<tr>
<td>Over pumping of chilled water loops</td>
<td>Excessive pump energy, pump wear and chiller efficiency</td>
</tr>
</tbody>
</table>
| Comfort sacrificed to obtain efficiency                      | Opens chilled water bypass valve (wasted pumping and low delta-T"
| Total plant energy performance not fully measured           | Transfers energy use from chilled water pumping to AHU fan motors |
|                                                             | Uncomfortable occupants = reduced productivity                |
|                                                             | Difficult to manage (increased risk)                         |
Chilled Water Optimization Strategy

Conventional methods of optimization

- Reset chilled water temperature up
- Chillers sequenced via a database of load profiles
- They all try to find a “sweet spot”

Comprehensive optimization

- Varying chilled and condenser water flows widens “sweet spot”
- Wider “sweet spot” = increased efficiency through the entire tonnage range
- Varying condenser water and chilled water through chiller
- Keeps chiller in design range (dT = 10F)
- Can increase tonnage delivered
Observations

- Poor low load efficiency
- Overlapping ranges for operating sequences
- Baseline average efficiency 0.783 kW/ton

Baseline Avg: 0.783 kW/ton

System Efficiency (kW/ton)

Total Cooling Load (tons)
P&G WHBC Chilled Water Optimization – Post Optimization

Observations
- More consistent efficiency across load range
- Very good low load efficiency
- Post-optimization average efficiency 0.675 kW/ton (14% improvement)
- Only 3 chillers needed at peak load

Baseline Avg: 0.78 kW/ton

Post-Optimization Avg: 0.675 kW/ton (14% improvement)

- 1 chiller on
- 2 chillers on
- 3 chillers on
- 4 chillers on

System Efficiency (kW/ton)

Total Cooling Load (Tons)
**Chilled Water Optimization Projects at Three P&G Facilities**

### Winton Hills Business Center (WHBC)

<table>
<thead>
<tr>
<th></th>
<th>Baseline (adj)</th>
<th>Actual</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Load (Ton-hrs)</td>
<td>11,438,549</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Use (kWh)</td>
<td>8,954,135</td>
<td>7,720,714</td>
<td>1,233,421</td>
</tr>
<tr>
<td>Efficiency (kW/ton)</td>
<td>0.783</td>
<td>0.675</td>
<td>14%</td>
</tr>
</tbody>
</table>

### General Offices (GO-Headquarters)

<table>
<thead>
<tr>
<th></th>
<th>Baseline (adj)</th>
<th>Actual</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual ton-hrs</td>
<td>4,953,942</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline Plant (kWh)</td>
<td>4,458,137</td>
<td>3,718,349</td>
<td>739,788</td>
</tr>
<tr>
<td>Efficiency (kW/ton)</td>
<td>0.900</td>
<td>0.751</td>
<td>17%</td>
</tr>
</tbody>
</table>

### Mason Business Center (MBC)

<table>
<thead>
<tr>
<th></th>
<th>Baseline (adj)</th>
<th>Actual</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual ton-hrs</td>
<td>20,297,811</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline Plant (kWh)</td>
<td>21,863,781</td>
<td>13,886,598</td>
<td>7,977,183</td>
</tr>
<tr>
<td>Efficiency (kW/ton)</td>
<td>1.077</td>
<td>0.684</td>
<td>36%</td>
</tr>
</tbody>
</table>

- **Total Annual Savings**
  - ~9,950,000 kWh per year = 7,050 metric tons of CO2
  - Equivalent to
    - Removing 1,530 vehicles from the road
    - Supplying electricity to 1,280 homes
- **Utility Rebate Funds Received**
- **Attractive ROI**
Chilled Water Plant Optimization Achievements

- Energy Savings
- Sustainability Impact
- Utility rebate funds paid
- Attractive ROI

- Improved reliability and operator confidence
- Additional capacity delivered
- Chilled water production better matches load
Operating Facilities to Demand instead of Schedule

Lighting Controls
Daylight harvesting, network of occupancy sensors to not only control lighting but provide building usage feedback.

Green Labs
Reducing energy and improving safety by giving lab owners control of occupancy. Provides visual alarms when air flow deviates from safe conditions.

On-Demand Ventilation
Using building occupancy information to adjust air handler operating schedules and fresh air setpoints.
Incorporating Ideas into Best Design Practices

Facilities that limit success

- Uncomfortable work environment
- Poor lighting and air quality
- Dissatisfied occupants
- Space is utilized poorly
- No funds for workplace upgrades
- Lack of flexibility

Facilities that contribute to success

- Safe and comfortable employees
- The building suits its purpose
- Ideal working conditions
- Savings are reinvested
- Happier, confident employees
- Occupants engaged with the building
Supplemental Slides
Why Focus on Cooling Systems?

Share of Energy Use for Office Buildings

10% by BTU consumption

13% by expenditure and GHG impact

Sources: US EIA, CBECS study 2012 Table E2 for Office Buildings. (2018 data not yet available, but cooling share expected to increase).