Industrial Demand Response

June 21st, 2022
11:00 AM – 12:00 PM ET
Bruce Lung
BGS-LLC, embedded in U.S. Department of Energy’s Advanced Manufacturing Office
To help combat dispatching additional power plants, utility companies can instruct both commercial and industrial customers to reduce their load on an ad-hoc basis, while others offer “interruptible” electric rates.

Read more in Demand Response in Industrial Facilities: Peak Electric Demand now available online.
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Today’s Presenters

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Oak Ridge National Laboratory

Jesse Tootell  
Lineage Logistics

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Los Angeles Department of Water and Power
Paulomi Nandy
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Demand Response in Industrial Facilities:

Peak Electric Demand

Paulomi Nandy
Alexandra Botts
Thomas Wenning
Using this guide

• Peak demand charges are very high
• Some form of demand response program possible for all facility type
• Understanding which time varying rates are best suited
• Understanding which demand response strategies are best suited
How is Electricity Generated?

- Electricity comes from many different sources
- Power is delivered to your facility through the **Grid**
- There are *base load* plants and *peak load* plants
- Peak load plants are dispatched during Peak Demand
Electric Consumption vs. Demand

- **Electricity consumption** (kWh) is the total electricity consumed.
- **Electric demand** (kW) is the rate at which electricity is consumed.
Industrial Sectors which are good Candidate for Demand Response (DR) Programs

- All industries can take part in DR program
- **Easy Candidate**: Facilities with more flexibility in product scheduling and process timing
- **Tough Candidate**: Facilities with continuously near their processing capacity
Types of demand

Seasonal Demand
- Varies slightly by regions in the country
- Affected mostly by weather

Daily Demand:
- Specific to individual customers.
- Affected by daily operation.
Types of Time Varying Rates

**Time of Use Pricing**: A rate structure that has a stepped rate structure for on-peak and off-peak hours for predetermined block of time

- **Bill Volatility**: ★★★
- **Bill Savings**: ★★★

**Peak Time Rebate**: A rebate for members who reduce electricity consumption when the grid load is critical.

- **Bill Volatility**: None
- **Bill Savings**: ★★★★★

**Critical Peak Pricing**: A period of time in the day when the grid load is critical, price may increase dramatically

- **Bill Volatility**: ★★★★
- **Bill Savings**: ★★★★
Types of Time Varying Rates

**Coincidental Peak Demand:** The time period when facility peak coincides with the grid demand.

- **Bill Volatility:** ★★★
- **Bill Savings:** ★★★★★

**Variable Peak Pricing:** On-peak and off-peak periods are defined in advance based on anticipated peak demand period. The prices in the other periods do not change from day to day.

- **Bill Volatility:** ★★★★★
- **Bill Savings:** ★★★★★

**Real-Time Pricing:** Dynamic pricing rates reflect the variation of wholesale electricity prices.

- **Bill Volatility:** ★★★★★★
- **Bill Savings:** ★★★★★★
Demand Response Strategy in a Facility

Office Space
- Lights
- Plug-loads
- HVAC Flow Control

HVAC

Cooling Tower

Maintenance Operations
- Boilers
- Compressed Air
- Pumping System

Warehouse
- Charging Stations
- Lighting

Critical Operations
- HVAC Temp Setback
- Lighting
- Exhaust

Occupancy Sensor
- BMS Control
- Manual Adjustment

Shop Floor
- Machining Equipment
- Process Flow
- Cycle Schedule

Building Management System (BMS) Inputs
- Weather
- Utility Demand
- Production Shift
- Renewable Energy

Smart Meter

Utility

Solar
- Battery
- Thermal
- Wind
Demand Response Hierarchy

- Eliminate Load
- Reduce Load (Energy Efficiency)
- Move Load (Demand Management)
- Substitute Load (Generation)

Highest Load Adjustment

Highest Load Growth Potential
Demand Management Strategies

- Battery Storage, Shift cooling load, Shift equipment charging
- Temperature setback on HVAC, Dimming of lights, Turn off plug loads
- Renewable energy onsite with storage, Combined Heat and Power (CHP)
Energy Efficiency and Demand Response

- Energy Efficiency is always the first and foremost strategy when reducing energy consumption.
- Energy Efficiency reduces costs through consuming less energy.
- Identifying inefficient energy use in the facility can help permanently reduce energy use and reduce the overall demand at a facility.
- Shutting down equipment or putting it in standby mode when not in use is often the simplest way to reduce energy demand.
Automated Demand Management

• Most sophisticated method load shifting and shedding
• Automatically sheds loads based on pre-programmed instructions.
• Customer works with experienced 3rd party to identify areas to curtail their load
• Customers can have combination of advanced EMS with Internet of Things (IOT), metering and submetering system and advanced control system
Cleveland Cliffs takes part in different DR program to reduce their load within short notice to help relieve the load on the grid.

Agropur has taken part in both electric and natural gas demand response program for over 14 Yrs.
Future Webinars

Link to the doc:

• https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Demand%20Response%20in%20Industrial%20Manufacturing_Final.pdf

Additional Questions:

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• bottsam@ornl.gov
• john.oneill@ee.doe.gov
Jesse Tootell
Senior Manager, Energy Analytics / Lineage Logistics
We Store, Move, and Prepare the World’s Food

- **Grown or Produced**
- **Moved to Production Warehouse**
- **Stored Safely by Lineage**
- **Moved to Distribution Warehouse**
- **Distributed to Store or Restaurant**
- **Consumed by Families**

[Diagram showing the process of food storage, movement, and preparation]
Fueling Growth with Data: Lineage Applied Sciences

SCIENCE FOCUSED TEAM

...utilizing big data and technology to revolutionize...

COLD CHAIN OPERATIONS

WAREHOUSE DESIGN

Full Automation:
- Proprietary software stress tests building design against customer profiles to ensure success

ENERGY OPTIMIZATION

Blast Cell Redesign:
- Redesign blast cell using computational fluid dynamics principles to minimize electricity usage and maximize product quality and throughput

TRANSPORTATION OPTIMIZATION

Data Mining:
- Integration of datasets creates opportunity to fill empty miles and match backhaul routes
- Lineage manages 2-3% of trans in the network; total market value is ~$12B

LABOR MANAGEMENT

Dynamic Slotting:
- Modify product arrangement to minimize travel time of MHE operators to move fastest turning product

Directed Tasking:
- Algorithm-based task determination matches put-away and pick-up activities to increase labor efficiency in and out of the freezer
Power Cost = Thermal Work ($kW_T$) $\times$ Efficiency $\left(\frac{kW_E}{kW_T}\right)$ $\times$ Price $\left(\frac{\$}{kW_E}\right)$

Emissions = Thermal Work ($kW_T$) $\times$ Efficiency $\left(\frac{kW_E}{kW_T}\right)$ $\times$ Carbon $\left(\frac{CO_2}{kW_E}\right)$
ELIMINATE LOAD
EFFICIENCY
SCHEDULING: Shedding and Shifting
DEMAND RESPONSE
ONSITE GENERATION
Industry Standard

**Flywheeling**

- Temperature limit
- Peak hours

**Industry Standard**

- Temperature (°F)
- Power (KW)

6:00 AM, 12:00 PM, 6:00 PM, 12:00 AM

**Flywheeling**

- Temperature (°F)
- Power (KW)

6:00 AM, 12:00 PM, 6:00 PM, 12:00 AM
Thermal Flywheeling Test

Fit Function: \( f(t) = A + mt + Be^{-t/\tau} \)

- Temperature Data (Cooling)
- Theoretical Fit (Cooling)
- Temperature Data (Warming)
- Theoretical Fit (Warming)

Cooling Period = 15.0 hrs
Heating Period = 8.0 hrs
BLAST FREEZING

Old Design

New Design
Simulation of food in a box surrounded by a layer of air

Temperature for of cube of food with phase change

Modulating blast ON-OFF time segments leads to different freeze times

Blast schedule optimization to maximize throughput and minimize energy costs
ELIMINATE LOAD
EFFICIENCY
SCHEDULING
DEMAND RESPONSE
ONSITE GENERATION
Year (June-May) | Sites Enrolled | MWs Enrolled | Performance (%) | 2 hrs | 10 hrs
--- | --- | --- | --- | --- | ---
2020-2021 | 47 | 30.6 | 84% | 52,000 | 260,000
2021-2022 | 73 | 52.7 | 92% | 90,000 | 450,000
2022-2023 (exp) | 99 | 74.5 | - | 118,000 | 590,000

Factors to Consider For Programs
- Manual, Preset, or Automated DR
- Notice, Frequency, and Response Time
- Ambiguity or Certainty (e.g., BIP, CP, ERS)

2023 Demand Response Market Participation (16 states)

*US EIA—average US grid emissions of 850lbs of CO₂ / MWh
Site Response

EXTREME PRICING ALERT for Wednesday, July 25, 2018

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Facility Y | Energy Trading

Power

- Facility Power
- Prepaid Power
- BiP Events
- Revenue

Price

- Hedge Price ($)
- Market Price ($)

Cost

- Cumulative Cost ($)
- Hourly Energy Cost ($)
Joe Benyon
Mechanical Engineering Associate / Los Angeles
Department of Water and Power
Water System Operations
Contribute to LA’s Grid Support

Joe Benyon
Mechanical Engineer
Water Operations – Pumps & Wells – Metro Group
Los Angeles Department of Water and Power

• Nation’s largest municipal utility
  • 8,000 MW Electric Capacity
  • 435 M Gallons served per day
  • 4 Million + Residents
    • 1.5 M Electric Customers
    • 735k Water Customers
  • 465 Square Miles
  • 11,000 + Employees

• 1902 – Began Serving Water
• 1916 – Began Supplying Power
LADWP – Water System

“...provide our customers and the communities we serve with reliable, high quality and competitively priced water services in a safe, publicly and environmentally responsible manner.”

- 113 System Pressure Zones
- 86 Pump Stations
- 325 Regulator Stations
- 120 Tanks & Reservoirs
- 35 Treatment Facilities
- 7,300 Miles of Distribution Mains
System Pressure Zones & Pump Stations

Diverse geography and wide array of demand requirements call for different supply strategies.

• Closed System Pumping
  • Small service areas with low demand
  • Pumps are in near-continuous operation

• Tank Storage
  • Tanks & reservoirs used to meet demand
  • Pumps operate periodically to fill tanks
Water System – Demand Response Program

- Began participating in summer 2016
- Shift loads to off-peak demand times
- 17 Pump stations in program
  - 20 system pressure zones
  - Pumps are turned off during peak demand periods
- Fill tanks & reservoirs prior to peak demand
  - Supply & Fire flow requirements met
  - Reduced emissions
Water System – Demand Response Program – Results

Data from last 3 Years of participation:

• Reduced grid demand by 7,100 kW per event
  • Exceeds 4,000 kW commitment
• Shifted a total of 388,000 kWh of energy use overall
• Avoided 100,000 lbs of CO₂e emissions
• 27% emissions reduction
Thank you

For more information about LADWP’s Demand Response Program, please reach out to:
Sustainability@ladwp.com
Q & A

Submit Questions
www.slido.com event code #DOE
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