INDUSTRIAL LOAD FLEXIBILITY

An Opportunity for Decarbonization in California

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CalPlug’s 10th Anniversary
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It is all About Decarbonization

Greater Decarbonization = More Renewables = More Flexibility

Clean Energy Generation Targets

Grid Decarbonization

Industry & Transportation

Reducing Carbon Content In Buildings

- Grid-scale renewables
- Low carbon fuels + carbon sequestration
- Grid Integrated End-Uses: DR & Customer Flexibility
- Efficiency (incl. BTM renewables)
- Electrification
- Embodied carbon
- Low carbon fuels

Economy Wide Emissions Reduction Goals

www.epri.com
Industrial Flexibility – Energy Use in Industries

California Emissions – 2019

Source: Patty Monahan, CEC Commissioner
2022 UC Davis Symposium on Industrial Decarbonization
Electricity and Natural Gas Consumption in the IAW Sectors in California

- A Oil and Gas Extraction and Mining Support
- B Food and Beverage
- C Textile Mills
- D Pulp, Paper, and Paperboard Mills
- E Petroleum, and Coal Products Manufacturing
- F Chemical Manufacturing
- G Plastics and Rubber Products Manufacturing
- H Glass Manufacturing
- I Cement
- J Primary Metal Manufacturing
- K Fabricated Metal Product Manufacturing
- L Semiconductor and Other Electronic Component Manufacturing
- M Computer and Electronic Product Manufacturing (excl. Semiconductors)
- N Electrical Equipment, Appliance, and Component Manufacturing
- O Agriculture, Forestry, Fishing, and Hunting
- P Animal Production
- Q Water Supply and Irrigation Systems
- R Irrigation Systems
- S Sewage Treatment Facilities
- T Data Processing, Hosting, and Related Services

Source: California Energy Commission, 2016
Increased Electrification and California’s Duck Curve

End-Use Load Flexibility is Necessary to Support the Grid
California Commercial Building Example – Grid View

Solar PV Only

Efficiency, Demand Response, THEN PV

Source: New Buildings Institute, PG&E Corp.

Source: Andrew McAllister, CEC Commissioner
2017 NA Konwakai
Available Demand Response Resources in Shift Events
The California Demand Response Potential Study, Phase 3, LBNL, 2020

Source: LBNL, DR Potential Study – Phase 3
Opportunities for Demand Response in California Industries

- Chemicals Industry
- Data Centers
- Agriculture – Water Pumping
- Domestic Water Supply and Wastewater Treatment
- Food Processing and Storage
  - Mainly Refrigeration
Chemicals Industry – Cryogenic Air Separation Plants

Source - Wikipedia
DR in Data Centers – Power Capping

Demonstrate potential of automatic IT loads reduction without disruption and minimal user impact

- Prepare for the future grid with greater renewables
- Adjust data center power needs to electricity availability
- Coordinate operations with utilities to avoid power interruptions
- Newer power capping technology available

Reference – Tests at Oracle
Server Power Capping/Demand Reduction Testing

- Evaluate power cap technology for automatic power demand reduction from IT equipment
- OpenADR signal to remotely trigger the event for automatic operation
- Tested in EPRI laboratory and at field site at Calit2 at University of California, Irvine
- Evaluate impact to IT equipment performance
- Lower core chip temperature a byproduct

Source – EPRI Report 3002019756
**Power and Time to Complete Workload**

- Power cap successfully limits average power, increases time to complete workload
- 15% power reduction (132-112W) with minimal increases time to execute (~10%)
- Further reductions dramatically increase execution time

Source – EPRI Report 3002019756
Agricultural Pumping

- Agriculture in California
  - Large User of Electricity
  - ~1.6 GW Summer Peak Load

- DR Programs Offered by Utilities
  - Pumping Interruptible Program
  - Other Auto DR Pilot Programs

Source – SCE and ETCC
DR Opportunities in Agriculture Pumping in California

- 1.1 GW DR Potential
- Relatively flat daily profiles
- Large, binary (on/off) loads
- Dual-use storage potential (reservoirs, canals)

Source:

[LBL Energy Technologies Area: Opportunities for Automated Demand Response in California Agricultural Irrigation, 2015]
Proof of Concept for Transactive Energy Based Load Shifting
CEC EPC-16-045 Project (Polaris Energy)

- 67% of load shifted from ramp hours of 94% that can potentially be shifted
- Energy users responded to signals for an average $0.14/kWh in incentives
- Reported improved crop and 30% labor savings
- ROI on automation investments for farmers range from 7-41% based on energy savings alone

Hourly Total Usage by Pump Before and During Transactive Energy Pilot: Apr - Jun

Source:
Flexible Water Pumping
CEC EPC-16-026 Project (EPRI)

Big Picture
- Large electricity user – ~6 GWh/year
- Demonstrate what it takes to make pumping flexible
- Prepare for future DR Programs

Objective
- 20% demand adjustment
- Support California policy goals for Demand Response and Renewable Integration

Activities
- Conduct industry interviews, data collection
- Identify DR Strategies, operational constraints
- Pilot test developed strategies
- Technology demonstration and final reporting
Decision Support Tools Developed for Operators to Take DR Actions
Flexible DR Opportunities in Refrigerated Warehouses
CEC EPC-16-026 Project (EPRI)

- Over 400 Refrigeration Plants in California
- Power Demand per Site – 250 kW to 4 MW
- Estimated DR Potential – 200 MW to 300 MW available

Equipment Available for DR
- Blast freezers: high capacity for fast cooling, reduces damage to food
- Freezer rooms: for long-term storage of packaged foods: must ensure that temperature remains below a specific setpoint, typically 0°F
- Additional equipment available for DR... (will be discussed)
Flexible DR Tests at Lineage Logistics in Mira Loma, CA

- ~700,000 sq. ft. Refrigerated Warehouse
- Up to 4 MW Capacity
- ~$2.2 mm Power Bill
- SCE Service Territory
- Direct Access Customer
- TOU + Demand Rate
Flexible DR – Project Goal and Approach

Goal
- Achieve 20% Demand adjustment – Up/Down

Approach
- Use frozen rooms as thermal batteries
- Control compressors that serve the frozen rooms
- Use OpenADR 2.0b to send DR signals and receive feedback
- **Power up events** – reduce temperature setpoint & adjust number of rooms to control magnitude of response
- **Power down events** – pre-cool frozen rooms prior to event, return temperature setpoint to original value at event
Flexible DR at Lineage – Communication Architecture

EPRI Database

MelRok

OpenADR 2.0b

CrossnoKaye

RTP Server

Controls Optimization Server

OpenADR 2.0b

DR Signal

Operational Data

Schedules Controls

DR VEN

EPRI VTN

Constellation Energy

Lineage plant at Mira Loma

Site Control System
(Industrial grade secured architecture)

Lineage plant at Mira Loma
Flexible DR – Results

Baseline: 1038 kW

Up: +272 kW (+26.2%)
Dn: -317 kW (-30.5%)
Load Shapes of Compressors & Other Loads

- **Total Compressor Power**
- **Other Loads**

**Floor Heaters**

**Electric Forklifts**
Other DR Resources: Floor Heaters and Forklifts

- **Floor heaters (700 kW):**
  - The thermal mass of the floor can be used as an additional storage device
  - DR with floor heaters is possible – and reacts instantly

- **Electric forklifts (500 kW):**
  - Forklift operations are currently being quantified by Lineage for future optimization
  - There is large potential for DR, but this is complex logistically and requires sophisticated tools
Next Phase – Dynamic Rate Pilot

SCE Dynamic Pricing Pilot
Hosted on the Retail Automated Transaction Energy System (RATES / UNIDE)

Device
- DCSI
- TeMix Agent™
- Transaction Interface

Device
- TeMix Agent™
- Transaction Interface

Device
- Agent

Device
- Agent

Meter

Retail customer, prosumer, distributed generation and storage Facilities

Automation Service Provider (Control)

Automation Service Provider (Transactive)

Device Control Service Interface (DCSI) [2030.5, CTA 2045, OpenADR, proprietary, etc.]

Subscription Transaction Rate (STR) - Hourly Subscriptions and hourly and sub-hourly tenders and transactions.

TeMix Platform™
Retail Transport
Retail Energy
Wholesale Energy

Tenders & Transactions

Tenders & Transactions (or Desired Schedules)

Distribution Operator (DO) Service Interface
DO operated by IOU, POJ & Microgrid Distribution Provider

Load Serving Entity (LSE) Service Interface
LSE operated by IOU, POJ, CCA & Microgrid Distribution Provider

Independent System Operator (ISO) Service Interface
ISO API
ISO / RTD in N.A.

Wholesale Service Interface
Wholesale Parties
Bilateral, Forwards & Futures

Tender Prices use Scarcity Pricing to Recover Fixed Costs

New SCE Project with TeMix, UDI and EPRI
Summary

- As the grid decarbonizes, loads need to become more flexible
- As industries decarbonize, electrification will increase
- Some industrial loads can operate flexibly
  - Ex: Food cold chain, water and wastewater treatment, agriculture, data centers etc.
  - Both power up and power down scenarios (Flexible DR)
- Opportunities for collaboration between utilities, energy service providers, end-use industrial customers and the government to enhance industrial load flexibility
  - Important to have domain knowledge when collaborating with industry
  - Dynamic rates may make a difference

Thank You for this Opportunity to Present!
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