

Demand Response Solutions for Commercial & Industrial Classes

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Utilities seek out Commercial and Industrial customers to help offset energy demands on the grid by offering C&I curtailment programs. Those programs evolve as regulations and smart grid technologies change. Eaton's C&I curtailment module solution provides customers the ability to choose options that match their business needs.

Introduction

Utilities are updating their Commercial & Industrial (C&I) Curtailment Programs to meet the requirements of the evolving smart grid. This new generation of program design offers enrollment terms and payments that meet the diverse needs of C&I customers. As we evolve to a grid with renewable generation and 5- or 15-minute energy markets, utilities are faced with the need to provide fast activating Demand Response (DR) solutions that deliver:

- Ancillary services and ramping support
- Local or System Level Capacity Reduction
- Energy market hedging resources
- Flexible Auto-DR capabilities and notification methods to support both automation of event activation and legacy notification
- Enrollment features that match customers' business operations to give them participation options

In order for a utility to benefit fully, it must be able to count on the resource just like any other generation asset in its fleet. This means that it needs to be available to the unit commitment component of the EMS and as a risk management component of energy markets. A survey of the industry has found that the following ingredients are requisite to a successful program:

- **Event Flexibility:** The utility must be able to use the program for contingency, curtailment and economic events.
- **Annual Commitment:** The utility requires an annual commitment from the customer for control in order to be able to effectively value the resource. The utility also needs the option to use the resources throughout the year.
- **Reserve:** Some of the C&I DR resource needs to provide system reserve or other ancillary services.
- **Customer Credits:** Customers must receive credits that fairly compensate them for their commitment and contribution which scales according to the annual hour commitment and notification time required.



Powering Business Worldwide

C&I customer's requirements are core elements of the C&I curtailment module. Eaton's solution provides customers the ability to choose options that match their business operations. Some key ingredients of the module are:

- **Customer Response Commitment:** The customer signs up for a response time of 10 minutes or less (Contingency and Reserve), 1-2 hour (Capacity and Economic), or 8 hours (day-ahead markets). This allows the allocation of the resources to minimize system constraints. It also provides a mechanism to allow any customer to participate.
- **Interruption Duration Minimum:** This option allows the customer the ability to create firm plans to comply with events. For example, in some cases, a facility may want to switch production schedules and may not be tolerant of short events. In other cases, a customer may switch to backup generation or put a process on hold where short duration events are not an issue.
- **Maximum Interruptions per Day:** This is another customer option that helps the customer plan response and allocate their resources for events.
- **Minimum Notice:** The minimum notification time for the customer so that they can be prepared to meet the objectives of the event.
- **Minimum Commitment:** The customer signs up for their total hours of annual interruption (e.g. 40, 80, 120 hours, etc.). This allows the resources to be allocated and optimized like other resources in the utility.

With these contract parameters key account representative or marketing organization can meet with customers and communicate the benefits of participating in the program resulting in higher enrollment ratios and customer satisfaction.

Eaton's C&I Curtailment module allows utility companies to implement a robust curtailment program that adheres to tariff rules, regulations, and remains within the contractual limits of their customers. The application supports the activation of events to support system and distribution operations, energy operations, and system emergencies:

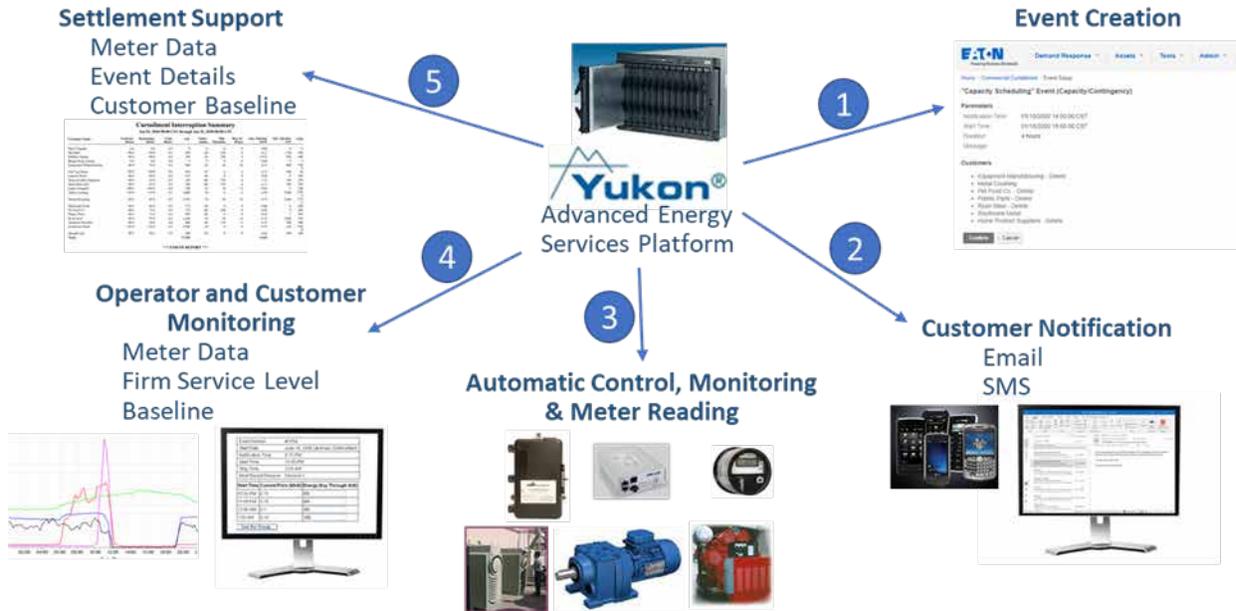
- **Contingency & Reserve Events (<10 Minute notice):** Operations can call upon the customers enrolled at this level for system support. The economic benefit to the utility is that these <10 minute resources can offset the reserve requirements.
- **Capacity Events:** Operations or Energy Markets can schedule capacity events to reduce system load or target a specific area within the system



- **Economic Events:** Energy Markets can schedule an economic event when market prices are high. The system supports the construction of economic events that allow the customer to curtail or purchase the energy at the market price (plus carrying charges). This gives the customer flexibility in deciding if the price point is worth the cost of curtailing their load.

Eaton is a leader in the development of power management solutions for commercial and industrial customers. Our solution supports a wide range of submetering and direct control field equipment to support customer programs.

Event Processing



The five phases of a load management program are shown in the figure. Eaton's C&I DR solution supports each of these functions for the utility and end customer.

- 1. Event Creation:** Utility Operations or Energy Markets schedule a control event. The operator enters the event parameters including start time and duration. The operator also selects the customer groups to include in the event. The system has defaults for notification time offsets, event time and duration, but the operator can modify those parameters as long as they comply with program rules.
- 2. Customer Notification:** The customer is automatically notified by the system that they have been scheduled for an event. The customer can have multiple contacts and each contact can be notified via text or email.
- 3. Automatic Control:** Resources that have direct control are automatically activated on event startup. A customer may have multiple control devices at their facility including discrete controls or interfaces to building control systems. Eaton supports both simple and sophisticated control strategies including the ability to validate facility isolation and reconnection to the grid.
- 4. Customer Monitoring:** Each customer is given a logon and access to the system via a web browser where they can monitor their load control during an event. Yukon supports the collection of live data from meters using multiple communication methods. Operators have access to monitor performance at an aggregate, group, or individual level.
- 5. Settlement:** Settlement data is provided to allow calculations against the tariff rules. Yukon provides event and interval metering data for settlement.

Event Creation

Customer	Current Load	CFD	Load Reduction	Constraint Status
<input checked="" type="checkbox"/> Equipment Manufacturing	1,873.0	1,000.000	873	76 Hours Remaining
<input type="checkbox"/> Metal Crushing	5,607.0	5,000.000	607	112 Hours Remaining Already in event at that time.
<input type="checkbox"/> Metal Shredding	2,790.0	2,500.000	290	76 Hours Remaining Already in event at that time.
<input checked="" type="checkbox"/> Pet Food Co.	1,532.0	800.000	732	76 Hours Remaining
<input checked="" type="checkbox"/> Plastic Parts	1,763.0	900.000	863	76 Hours Remaining
<input type="checkbox"/> Ryan Steel	1,457.0	250.000	1,207	72 Hours Remaining Already in event at that time.
<input type="checkbox"/> Southwest Metal	3,258.0	3,000.000	258	112 Hours Remaining Already in event at that time.

Load Reduction Selected: 2,468

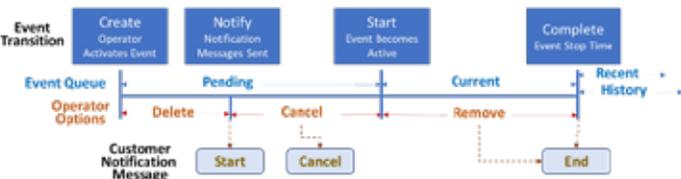
Next **Cancel**

One of the key functions of the C&I curtailment system is to ensure that operators activate events within the bounds of the tariff and customer contracts. The majority of the rule processing occurs during event creation, where operator entry is checked against the rules of the program and customer. If a customer passes rule checking, they are listed and the box in front of their name is checked. If during the rule checking, a customer fails a rule, the violation is listed, and the customer becomes unselected from the event. The operator is provided the list of customers and the total expect reduction from the event. They can modify the selection to match system requirements.

Notification Process

The Yukon C&I Load Management system includes a sophisticated notification system that covers the full event lifecycle. The process flow for notification and direct control events is shown in the figure.

Event Transition: Each event moves through the four states listed in the figure.



- **Event Queue:** The event is displayed on the operator and customer user screen in the appropriate queue. Operators can quickly understand activities that are active and those that are scheduled.
- **Operator Options:** The operator is presented with the following action options appropriate to the state of the event.
 - **Delete:** The operator can delete an event at any time after the event is created and before event notifications are sent to the customer.
 - **Cancel:** The operator can cancel an event between the transition states of Notify and Start. A cancel action will result in a Cancel message being sent to the event customers.
 - **Remove:** The operator can end the event early for customers by removing them from the event.
- **Customer Notification Message:** There are four basic message types sent to the consumer. The body of the message is customizable and program parameters can be included (e.g. event date, start time, end time, program names and other parametric information).
 - **Start:** The start time and duration of the event.
 - **Cancel:** The event will not occur.
 - **Adjust (Economic Events):** Provides updated duration or pricing information to the customer.
 - **End:** The event is complete and the customer can restore their load(s).

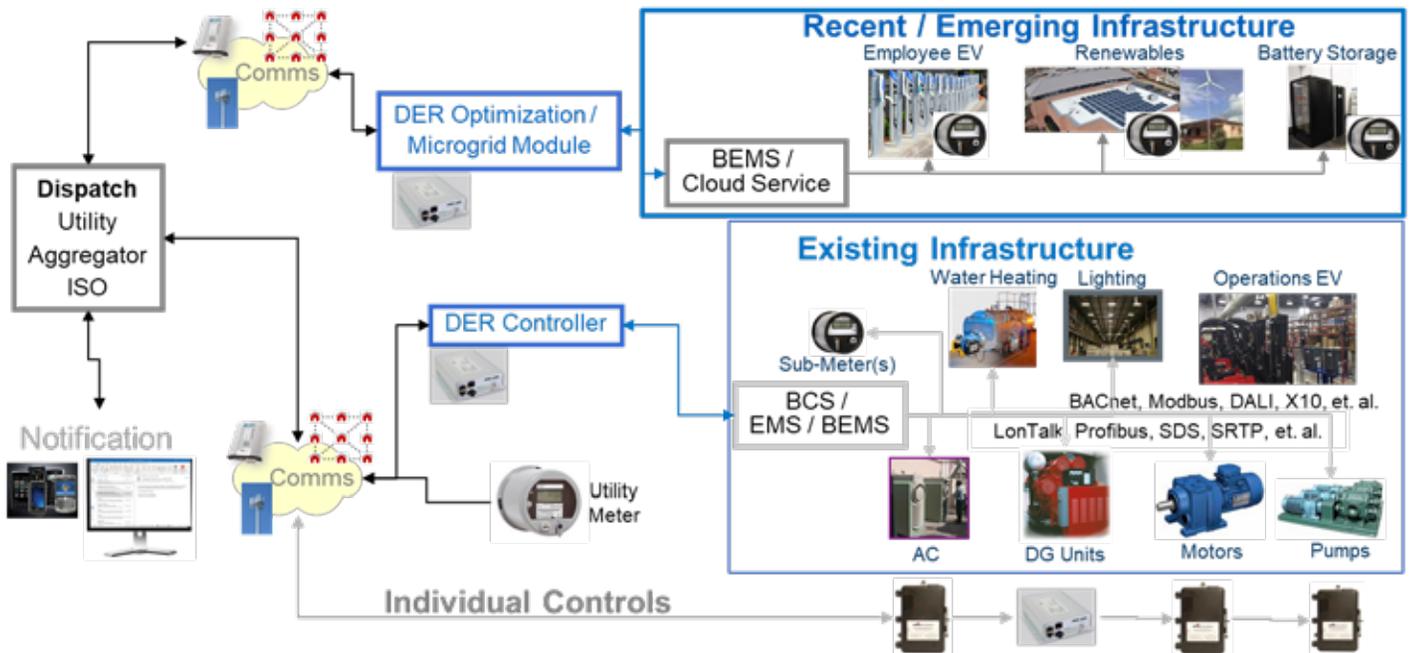
Direct Control

Eaton is a leader in the development of power management solutions for commercial and industrial customers. Our solution supports a wide range of submetering and direct control field equipment to support customer programs. Eaton supports industry standard communication protocols between the utility and the field equipment including DNP 3.0, IEC 61850, and ICCP. Communication from the gateway to the facility EMS/BCS includes a Modbus interface.

- **Device Control:** Eaton provides a range of solutions to directly control site loads including load control relay devices (LCR), RTU/ communication gateways and smart thermostats.
- **Facility Control:** Eaton field products can be connected to the facilities Building Management or Energy Management system. The field equipment can provide simple contacts to these systems or communicate directly to the system.

- **Supply Control:** Eaton has a range of utility grade single and three-phase sectionalizing devices and controllers.
- **DER Controller:** Eaton provides an intelligent controller for the C&I customer which automatically responds to curtailment events, configures available resources, and optimizes energy usage.
- **Microgrid Controller:** Eaton provides a full microgrid solution to customers that require high reliability and energy optimization. Algorithms in the microgrid controller allow the customer to participate in utility DR programs to offset the costs of the microgrid infrastructure.

The figure provides an overview of the methods and capabilities of the notification and control of C&I resources.



Monitoring

Yukon provides a set of tools allowing the utility and customer to monitor the system. Each customer is provided with a logon that gives them access to the following tabbed display:

- **Event Summary:** Displays all customer events. The events are displayed in Current, Pending, and Recent History Queues. This Event Summary tab allows the customer to view the details for their events.
- **Metering:** The Metering tab provides the customer with a display of their current loads. It also provides them with research tools to analyze their load including historical load and baselines.
- **Contacts:** The Contacts tab allows customers to adjust their contact information for notification and add additional contact personnel.

The Utility User has a wide selection of tools to monitor the system including the following:

- **Trending:** The utility can view loads in aggregate or as individual graphs.

- Individual trends can be built to show multiple curves per trend.
- **Data Viewer:** The DR Administrator can create customer displays for operators that provide event monitoring. These displays automatically update on any data point change.
- **Event Status:** The Event Summary screen shows the results of the notification to customers and provides a summary of the economic participant actions.
- **Load Control:** The Control Area screen provides the utility user with information on the status of each directly controlled resource at the customer site including the current load based on metering.
- **Reporting:** The Reporting system allows the utility user to get information on a wide variety of subjects for monitoring, managing, and troubleshooting the system.

M&V and Settlement

- A key element of any commercial and industrial demand response solution is the ability to monitor customer performance and perform settlement. Eaton's solution provides the ability to collect live metering from the customer meters, calculate baselines, provide the customer with live performance data, and aggregate the performance for the utility operator.
- Eaton's solution provides a number of options to collect commercial and industrial metering data ranging from a direct polling of a meter or a secondary device connected to the meter as well as interfacing to the utilities existing meter data collection system. The exact solution typically requires an in depth discussion of the program and utility requirements related to data acquisition, validation and available communication methods.
- Interval meter data is stored in Yukon and our platform allows the calculation of baselines and data aggregates. For example, an operator can view the aggregate performance of customers and an individual customer can view the data against their minimum commitment or baseline.
- The Yukon platform provides the utility with the ability to export event and performance data in flexible formats for settlement calculations.

About Eaton

Eaton's mission is to improve the quality of life and the environment through the use of power management technologies and services. We provide sustainable solutions that help our customers effectively manage electrical, hydraulic, and mechanical power – more safely, more efficiently, and more reliably. Eaton's 2019 revenues were \$21.4 billion, and we sell products to customers in more than 175 countries. We have approximately 93,000 employees. For more information, visit Eaton.com.

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