AUGUST 20, 2025

Opportunities to manage peak loads using your building automation system (BAS)

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Agenda

1. Welcome and introduction
2. Fundamentals of power and demand
3. Paying for peak demand
4. Peak demand reduction strategies
5. Useful tools
6. Case studies

Objectives

- Understanding peak loads and the impacts on building performance
- Basics of BASs and their role in identifying peak demand events
- Overview of the strategies to reduce peak demand using a BAS
- Leveraging advanced BAS tools and analytics
- Real-world example and outcomes of a peak load reduction strategy

Fundamentals of power and demand

Power and energy

Power – how high is a waterfall?

Energy – how much flow in the waterfall?

High power, low energy

High power, high energy

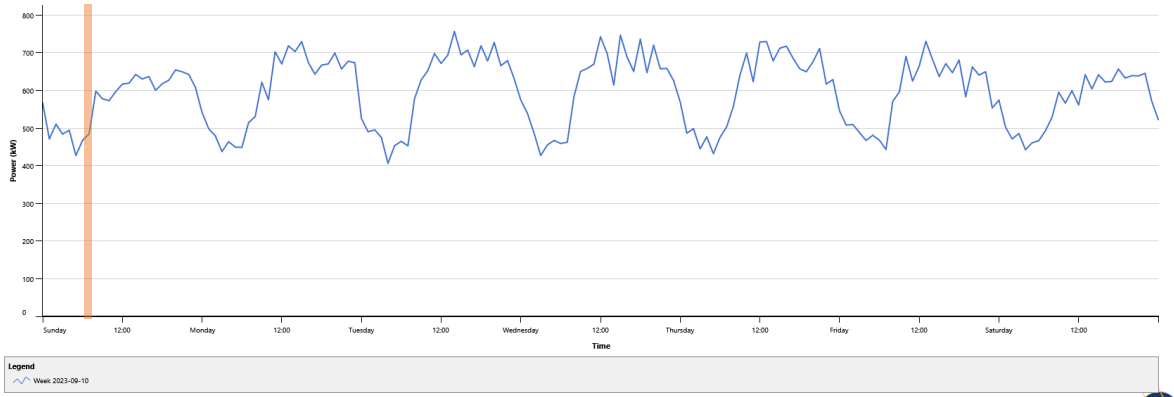
Low power, high energy

Peak loads and demand

- Peak loads do not always translate into peak demand.
  - Loads are instantaneous and represent the power drawn by a piece of equipment at any given time.
- Peak loads are used to set the size of your electrical service.
- Loads are based on the design parameters of your building, while demand is a utility defined concept.
- Demand is a specific combination of the electrical loads matching specific utility rate criteria.

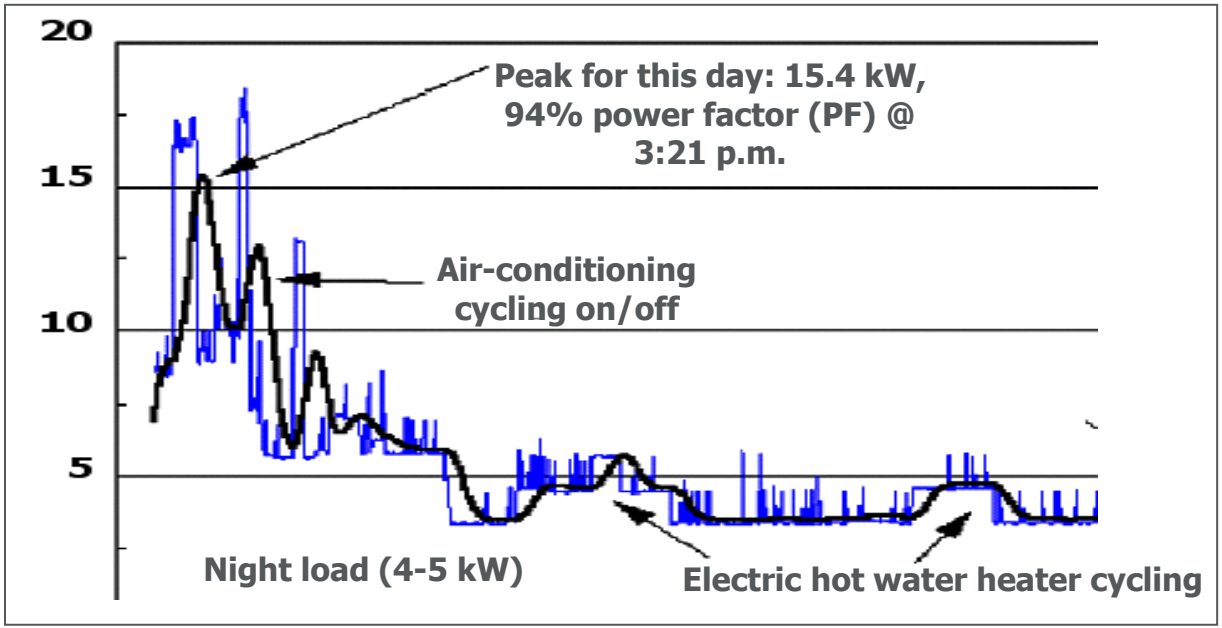
What is demand?

- Demand is a specific power drawn by a facility as defined by the utility company.
- Most utilities use the highest monthly drawn power averaged over a 15-minute period, often a rolling window, while some use a 60-minute average.



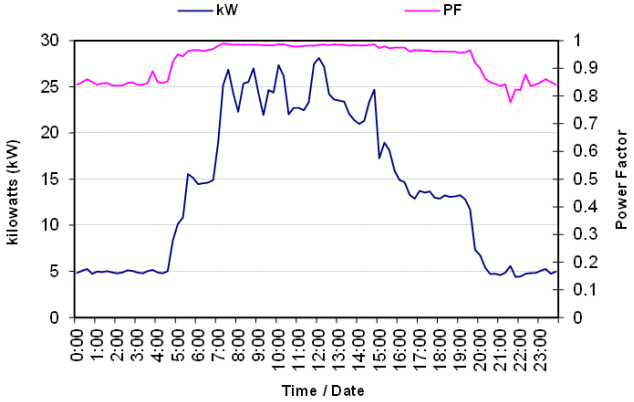
What the demand meter sees!

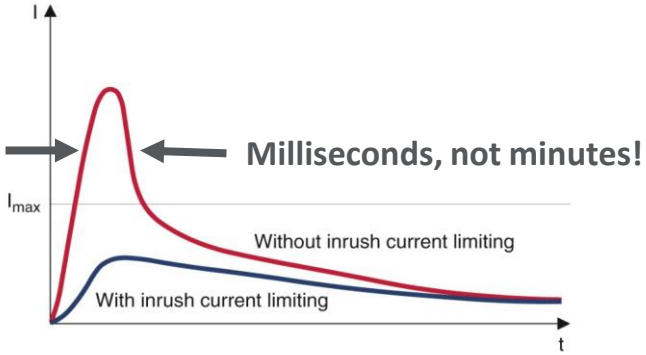
A 15-minute average



A few demand myths

- Start-up of facility always sets the peak demand.
  - Peaks often occur mid day or end of shift.
- Soft starts save demand.
  - Soft starts suppress in-rush current lasting milliseconds; the demand meter averages over 15 minutes!
- Starting all your air handling units (AHUs) at the same time creates a morning peak.
  - Only if they are direct expansion (DX) or have electric heat or the chiller is not well managed





Paying for peak demand

Know your rate!

- Unlike energy savings management, peak demand management is highly time-sensitive, and its value is strongly linked to the rate structure.
- In Ontario, the typical rate for customers with demand above 50 kW includes at least one demand charge element:

1. Delivery charge: includes many items with distribution and transmission being the main contributor to the demand cost – typically $10 to $16/kW (and/or kVA)
2. For customers in the Class A Global Adjustment category, a second significant demand charge element is applied.

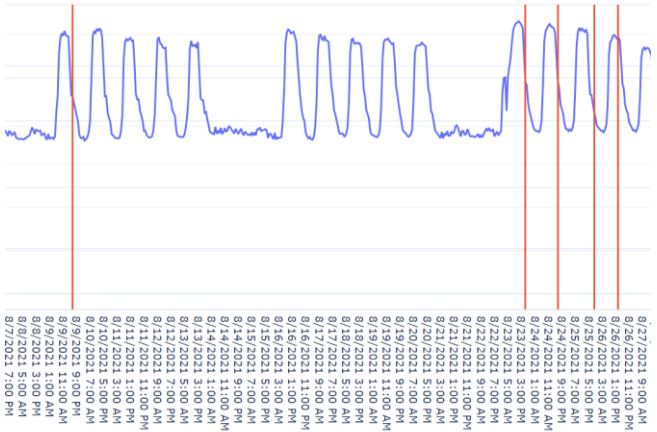
Class A commercial customers

As defined by the IESO, a facility can opt in for Class A if:

- Customer average monthly maximum hourly demand is greater than 1 MW but less than or equal to 5 MW
- Determined by calculating customer 12-month average of their highest hourly peak demand values for each of the 12 months of the base period

Global Adjustment structure matters

- Customers who participate in the Industrial Conservation Initiative (ICI) pay a Global Adjustment (GA) based on their contribution to the top five peak hours of energy use in Ontario over a 12-month base period (May 1 to April 30).
- This determines a facility's peak demand factor (*PDF*).
- The total charge is then that *PDF* times the total GA cost, using the *PDF* from the previous year.



Timing with demand management

- In all instances, just a slip of 15 minutes (to 60 minutes in certain cases) cancels out all previous peak demand management efforts for the whole month.
- For Class A customers, missing any peak hour results in increased demand charge for the entire following year at a value that can be in the $40/kW to $80/kW per occurrence. The range can vary significantly and was at $100/kW a few years ago.

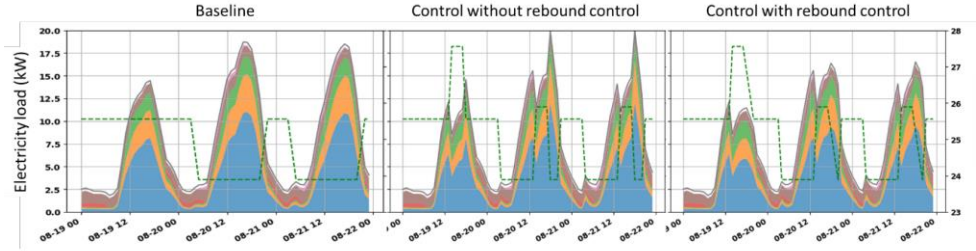
2024 GA hours

Rank	Date	Hour Ending (EST)
1	June-19-24	17
2	July-31-24	17
3	August-01-24	17
4	June-18-24	16
5	August-27-24	17

The Two Sides of Peak Demand Management

1. Manage your own monthly peak demand
   - Not dependant on any external factor
   - Cost savings are purely based on your utility rate
2. Respond to the utility peak demand – Demand Response (DR)
   - Done through a utility rate structure, such as ICI-Class A
   - Done through specific DR initiatives
   - Financial return is based on either the rate structure (Class A) or the DR program

One does not preclude the other, but care must be taken to avoid interference between the two, such as rebound peaks.



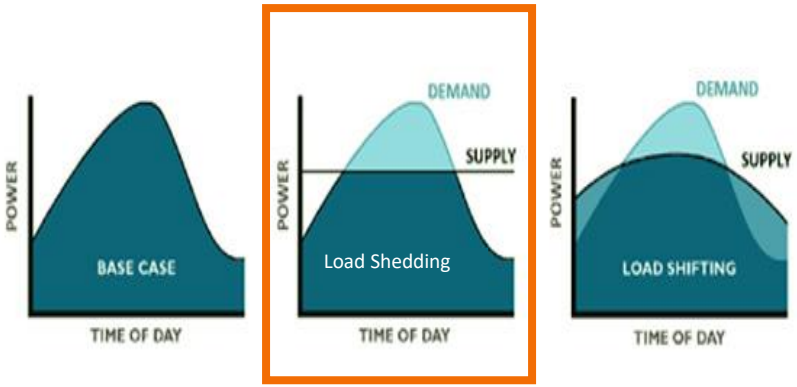
End-Use Savings Shapes Measure Documentation: Thermostat Control for Load Shedding in Large Offices, National Renewable Energy Laboratory

Peak demand reduction strategies

Main demand management strategies - 1

1. Load shedding

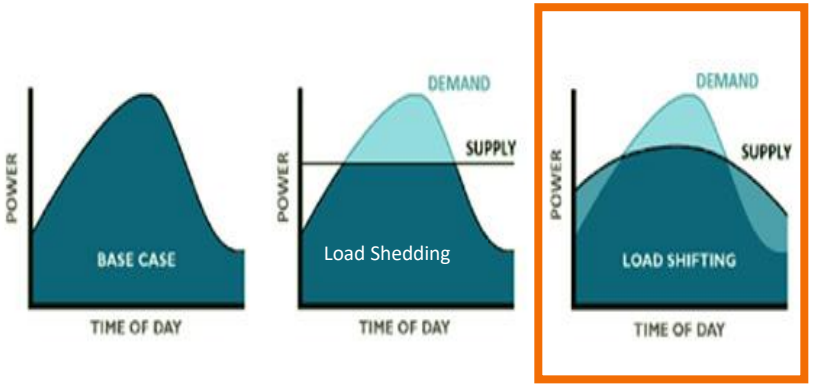
- A temporary reduction in energy consumption involves turning off non-essential equipment during peak demand.
- Examples: dimming lights or temporarily powering down office equipment, slowing down fans, pumps, etc.
- Most common, more easily done with BAS, no additional equipment



Main demand management strategies - 2

2. Load shifting

- It involves rescheduling energy-intensive tasks to off-peak hours.
- Example: pre-cooling a building before peak periods as well as using energy storage, moving production in industrial cases, etc.; may require some sort of storage (heat, cold, electric)

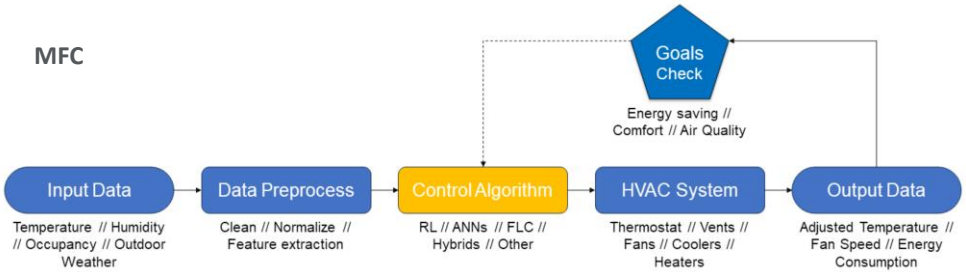


Main demand management strategies - 3

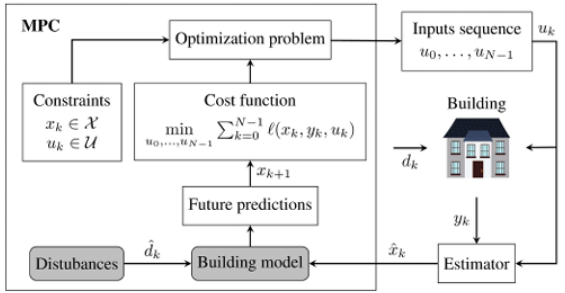
3. Model predictive control (MPC) and Model-Free Control (MFC)

- Leveraging data analytics and AI-driven forecasting enables proactive system adjustments to optimize performance during peak demand periods.

The first three strategies typically require integration within a BAS.



Model-Free HVAC Control in Buildings: A Review, Energies 2023, 16(20), 7124



All you need to know about model predictive control for buildings, Annual Review in Controls, volume 50, 2020

Main demand management strategies - 4

4. Energy efficiency

- Upgrading to energy-efficient equipment, such as light emitting diode (LED) lighting, can significantly reduce overall energy consumption and peak energy consumption.
- In contrast, many control-based energy-efficiency measures offer limited or no impact on peak demand.

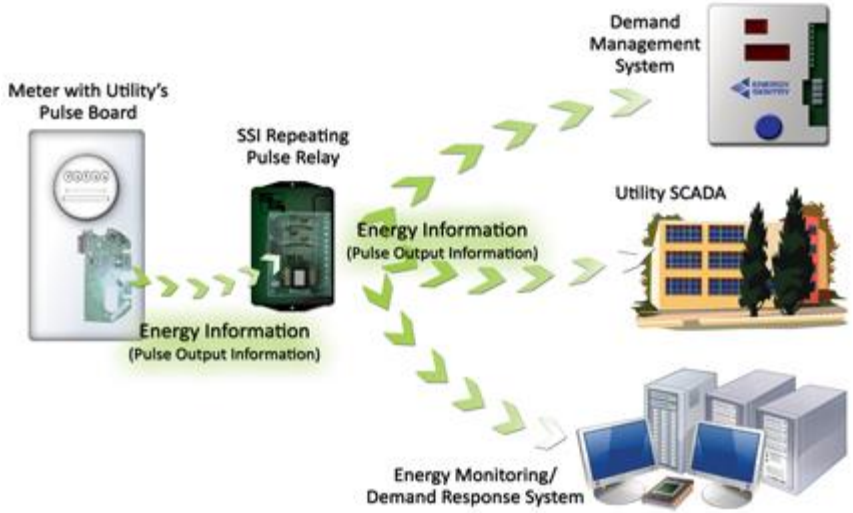
5. Education and engagement

- Encouraging building staff and occupants to adopt energy-saving behaviours, such as turning off lights and computers when not in use, contributes some peak demand reduction.

Step-by-step approach

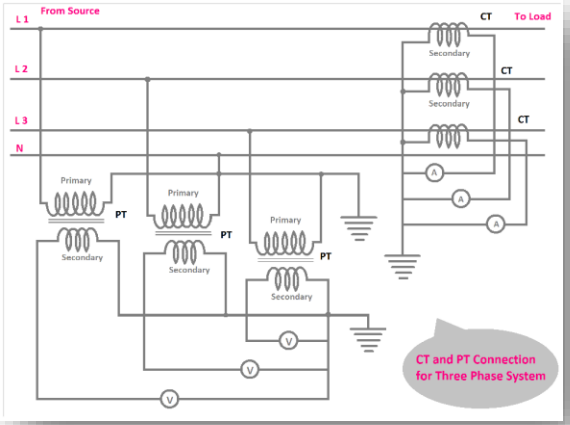
1. Measure the demand in real time
2. Conduct an inventory of electrical loads for load management
3. Establish a maximum demand value that is achievable
4. Review your operating procedures to avoid synchronized short-term operation (e.g. more than 15 minutes), ex. building electric heating warmup, cooldown in the summer
5. When billed on kVA, check your power factor
6. For GA, ensure to have adequate alarms (references: https://www.ieso.ca/peaktracker, https://www.ieso.ca/power-data)
7. Program the BAS, commission and test the sequence… and properly train staff!

Connecting the BAS to a pulse demand meter



https://solidstateinstruments.com/newsletters/additional-outputs.php

Customer-installed (shadow) meter

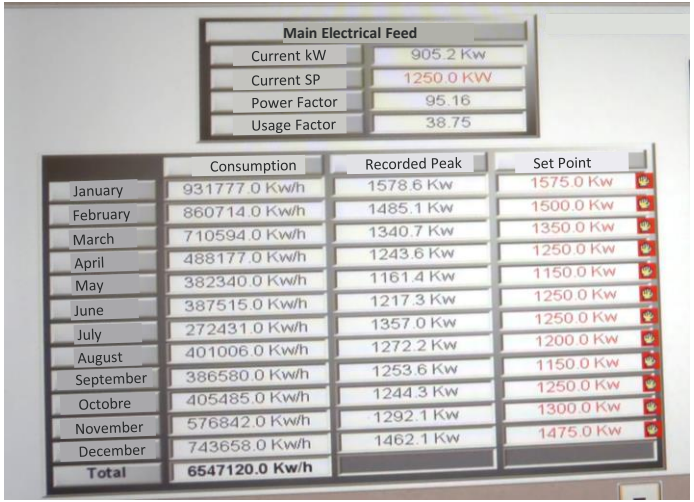


ieso Connecting Today. Powering Tomorrow.

SAVE ON ENERGY POWER WHAT'S NEXT

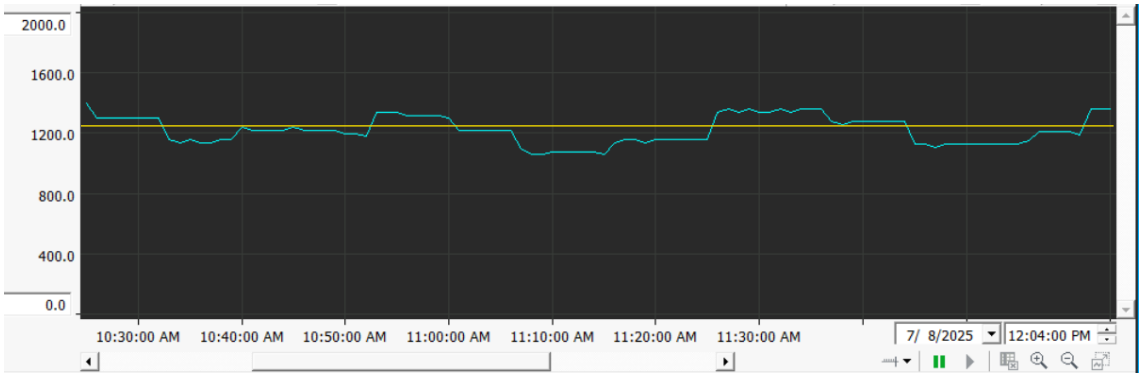
Setting up your BAS for demand management

- Regardless of rate class, the BAS needs to be configured to enable demand management:
  - For normal monthly peak management, a dedicated screen is needed with the monthly setpoints established usually based on a cost criteria, also considering the result of an equipment survey and occupancy constraints.
  - A preprogrammed sequence is used for normal peak control.
  - For Class A and/or DR, a specific sequence needs to be programmed and readily available.



Validating results on the BAS

- A trend graph needs to be one-click accessible to operators.
- Training is essential so that operators know what to expect and how to detect potential issues.



Demand management opportunities

Implementation of demand-side management (DSM) opportunities

Start from the inventory you established

- Establish a breakdown of your peak demand for each month and/or GA hours.

Quantify the possible reductions

- Using the identified reduction and historical monthly peak, establish monthly setpoints.
- Perform actual tests to validate impact on demand and on conditions (e.g. comfort)

Establish the control sequence and program the BAS

- Conduct comprehensive testing of the sequence by lowering the activation setpoint and evaluating the resulting demand reduction using BAS trend data to validate performance
- Validate any impact on indoor conditions and/or other services
- Validate that no rebound effect cancels out the managed reduction
- For GA/DR, validate the duration of the sustained reduction and impact on services

Some typical demand management opportunities - 1

Load shedding (peak shaving) has a small energy impact as loads are not recovered later:

- Alternative supply integration: use backup generators or hybrid heating systems as part of peak demand strategies, ensuring coordination through the BAS for seamless operation
- Lighting reduction: lowering or turning off lighting has no rebound effect and is most effective when integrated into BAS routines, except potentially during GA/DR-managed events done manually

Some typical demand management opportunities - 2

- Ventilation setback: short-term ventilation reduction depends on system type and must be paired with air quality monitoring; rebound effects may occur if done before end of day

- Air balance consideration: ensure exhaust air and supply air remain balanced; reducing supply below exhaust levels may negate energy savings

Some typical demand management opportunities - 3

- Reducing fan speed: typically achieved through direct or indirect setpoint adjustments, commonly by lowering static pressure setpoints; this may impact space temperature control, resulting in a similar measure as below.
- Modifying setpoints (heating/cooling): high risk of a significant bounce back effect; the recovery must be done gradually through the BAS, and setpoint adjustments should be limited in depth to maintain comfort. It must be tested! Peak demand reduction of about 2%- 5% during the cooling season for a 2 ^{o}C rise in set point (Thermostat Control for Load Shedding in Large Offices ,National Renewable Energy Laboratory).
- Reducing pump speed: implemented via direct or setpoint adjustments, typically in secondary loops to avoid affecting primary equipment; this may impact space temperature control, resulting in a similar measure as above.

Some typical demand management opportunities - 4

Changing chiller setpoints:

- Adjusting chilled water supply and cooling tower return setpoints can deliver immediate demand reductions similarly to raising space temperature setpoints.
- In variable flow loops, pump speed increases if no other actions are taken! This can negate a large part of a demand reduction.
- The bounce back effect is always present and must be managed for normal peak demand management.

Stopping non-critical systems:

- Electric humidifiers
- Hot water heaters: care must be taken due to possible bacterial issues

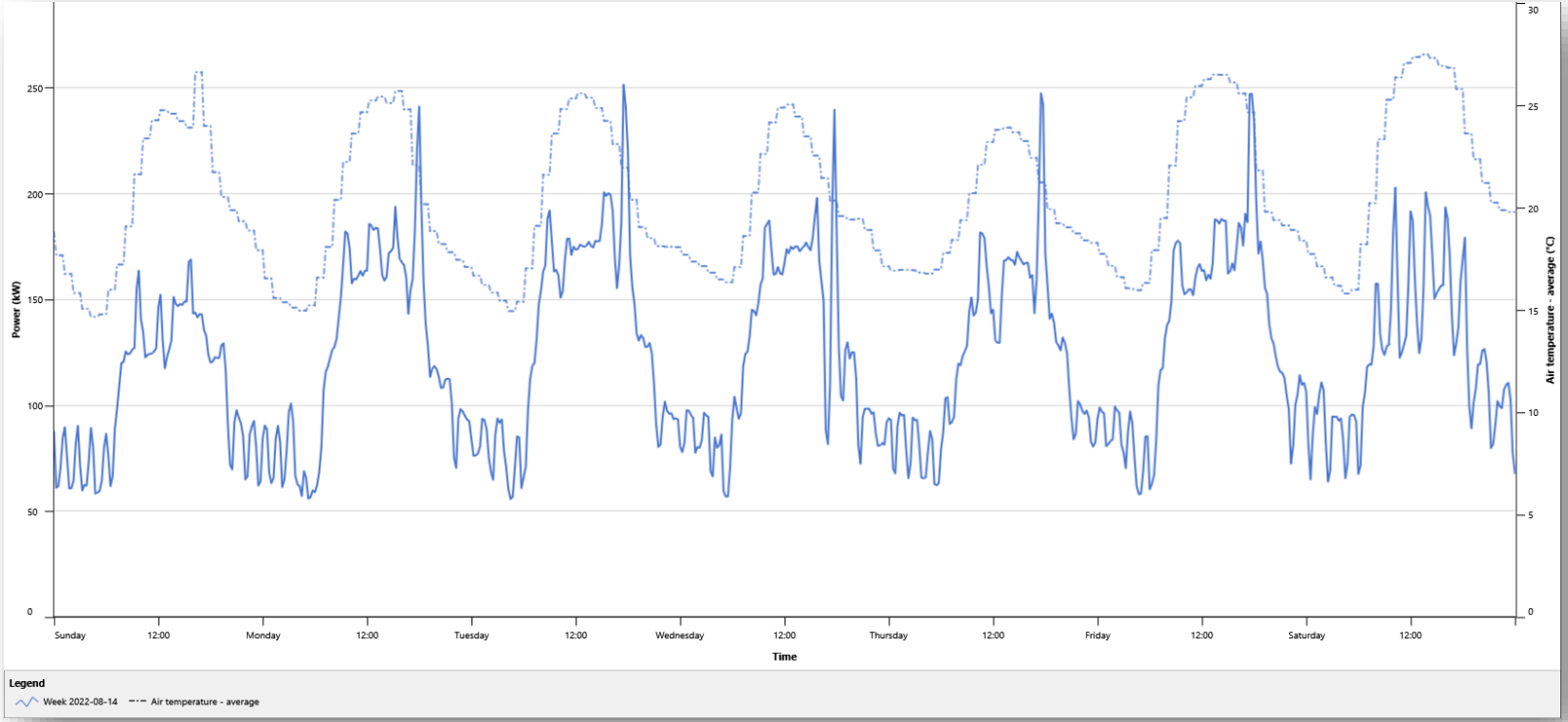
Some typical demand management opportunities - 5

- Load shifting: there is no net energy impact or minimal energy impact since loads are met either before or after the demand curtailment.
  - Leverage building thermal inertia to temporarily reduce heating/cooling demand, an approach aligned with MPC/MFC strategies. Building pre-heating and pre-cooling is subject to comfort limits.
- Thermal storage: applies to both heating and cooling for short-term load shifting (hours, not days); it can improve equipment efficiency at partial load, although thermal storage losses may offset gains; typically, not considered an ECM
- Electric storage: it is load shifting since electricity consumption is moved from peak periods to off peak (recharging).
- For industrial: modifying production schedule

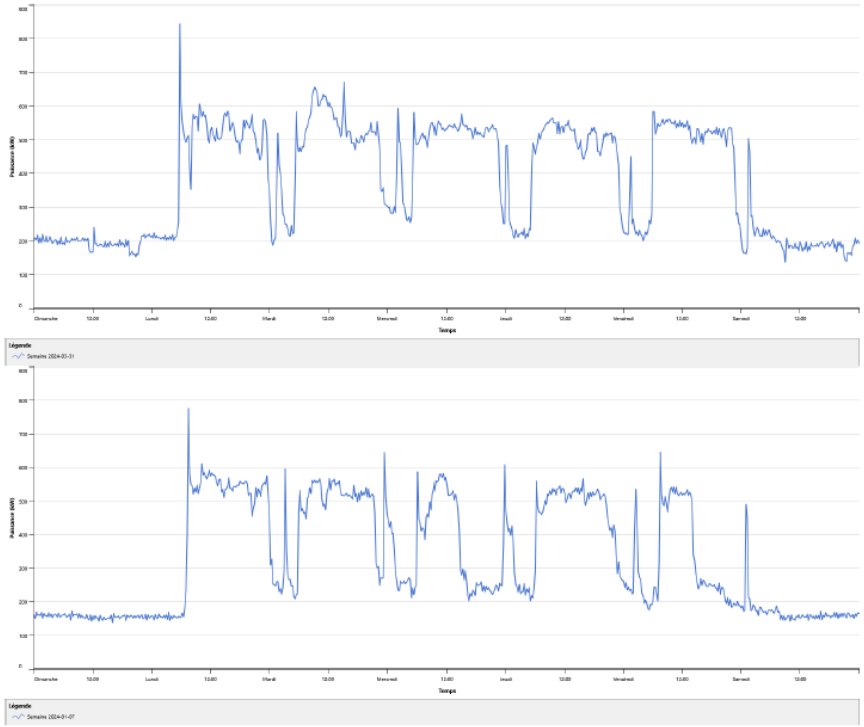
Eliminate accidental peaks

1. Review history to identify and eliminate accidental peaks (staff training opportunity)
2. Start all AC systems at the same time for cooldown
3. Use deep setbacks on cold nights when using electric heating or heat pumps
4. Photocell sensor failure causing all outdoor lighting to be on during daylight hours
5. Heating distribution pumps running in summer when chiller is on and heat is not required
6. Performing an equipment test (such as on a chiller) at the end of the month when the equipment is not required for the remainder of that month
7. Do not run systems 24/7 to avoid peaks, it can be done efficiently while still scheduling systems!

Control issues cause accidental peaks



Lack of awareness creating accidental peaks

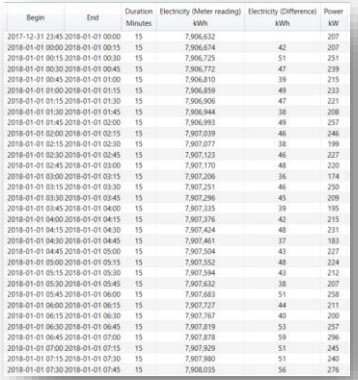


Tools for analyzing demand

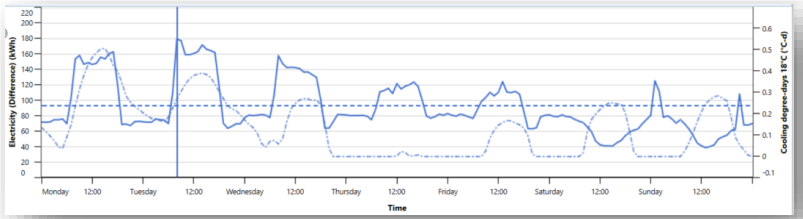
BAS tools

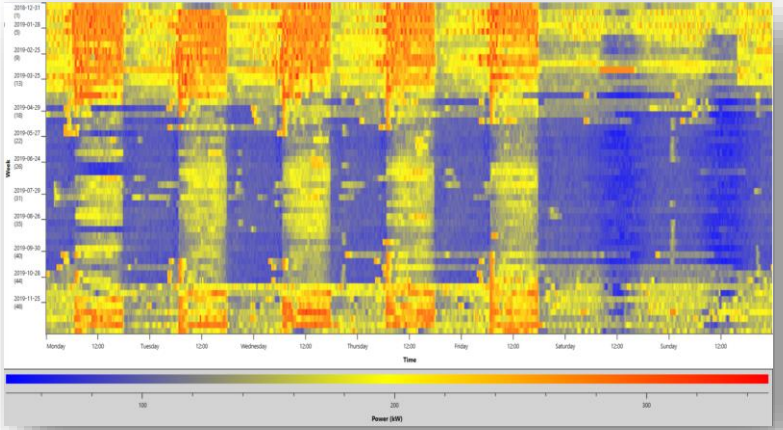
- Some fault detection and diagnostic (FDD) packages include peak demand analytics.
  - Demand information from the grid, meter data from a building
  - Used for GA/DR response
- MPCs/MFCs can be used with a BAS to optimize peak demand management
  - Use AI and machine learning to analyze historical data, predict future demand and optimize building energy use in real time
- Use trend data
  - Understand building profiles and behaviour by routinely inspecting demand profiles
  - Correlate with outdoor temperature, time of day and day of the week: your own model!

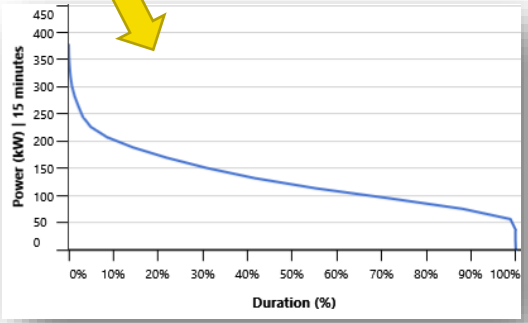
RETScreen Expert - demand analysis tools



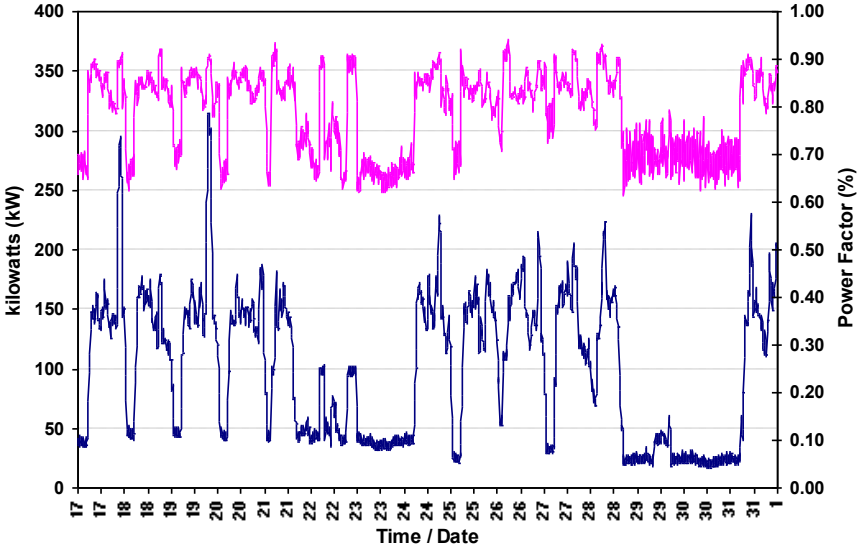
Begin	End	Duration Minutes	Electricity (Meter reading) kWh	Electricity (Difference) kWh	Power kW
2017-12-31 23:45	2018-01-01 00:00	15	7,906,632		207
2018-01-01 00:00	2018-01-01 00:15	15	7,906,674	42	207
2018-01-01 00:15	2018-01-01 00:30	15	7,906,725	51	251
2018-01-01 00:30	2018-01-01 00:45	15	7,906,772	47	239
2018-01-01 00:45	2018-01-01 01:00	15	7,906,810	39	215
2018-01-01 01:00	2018-01-01 01:15	15	7,906,859	49	233
2018-01-01 01:15	2018-01-01 01:30	15	7,906,906	47	221
2018-01-01 01:30	2018-01-01 01:45	15	7,906,944	38	208
2018-01-01 01:45	2018-01-01 02:00	15	7,906,993	49	257
2018-01-01 02:00	2018-01-01 02:15	15	7,907,039	46	246
2018-01-01 02:15	2018-01-01 02:30	15	7,907,077	38	199
2018-01-01 02:30	2018-01-01 02:45	15	7,907,123	46	227
2018-01-01 02:45	2018-01-01 03:00	15	7,907,170	48	220
2018-01-01 03:00	2018-01-01 03:15	15	7,907,206	36	174
2018-01-01 03:15	2018-01-01 03:30	15	7,907,251	46	250
2018-01-01 03:30	2018-01-01 03:45	15	7,907,296	45	209
2018-01-01 03:45	2018-01-01 04:00	15	7,907,335	39	195
2018-01-01 04:00	2018-01-01 04:15	15	7,907,376	42	215
2018-01-01 04:15	2018-01-01 04:30	15	7,907,424	48	231
2018-01-01 04:30	2018-01-01 04:45	15	7,907,461	37	183
2018-01-01 04:45	2018-01-01 05:00	15	7,907,504	43	227
2018-01-01 05:00	2018-01-01 05:15	15	7,907,552	48	224
2018-01-01 05:15	2018-01-01 05:30	15	7,907,594	43	212
2018-01-01 05:30	2018-01-01 05:45	15	7,907,632	38	207
2018-01-01 05:45	2018-01-01 06:00	15	7,907,683	51	258
2018-01-01 06:00	2018-01-01 06:15	15	7,907,727	44	211
2018-01-01 06:15	2018-01-01 06:30	15	7,907,767	40	200
2018-01-01 06:30	2018-01-01 06:45	15	7,907,819	53	257
2018-01-01 06:45	2018-01-01 07:00	15	7,907,878	59	296
2018-01-01 07:00	2018-01-01 07:15	15	7,907,929	51	245
2018-01-01 07:15	2018-01-01 07:30	15	7,907,980	51	240
2018-01-01 07:30	2018-01-01 07:45	15	7,908,035	56	276

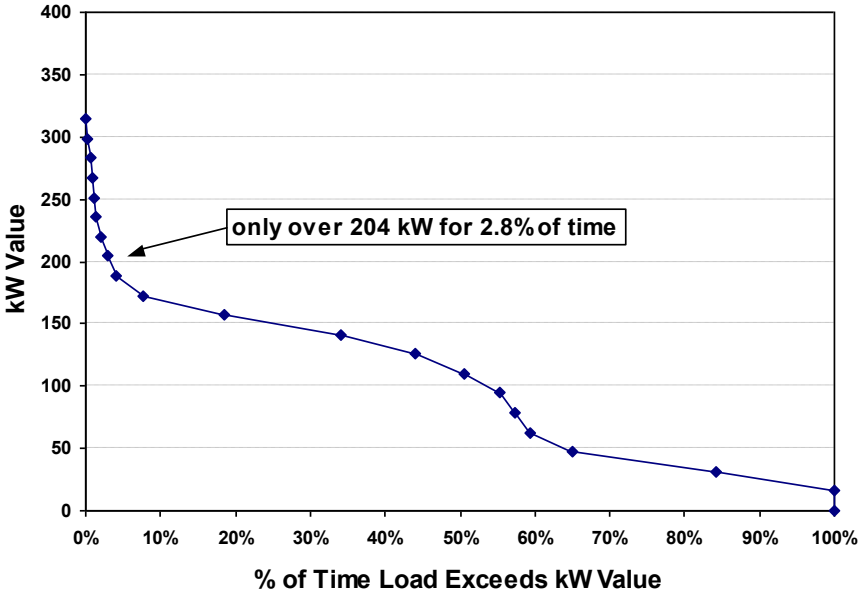




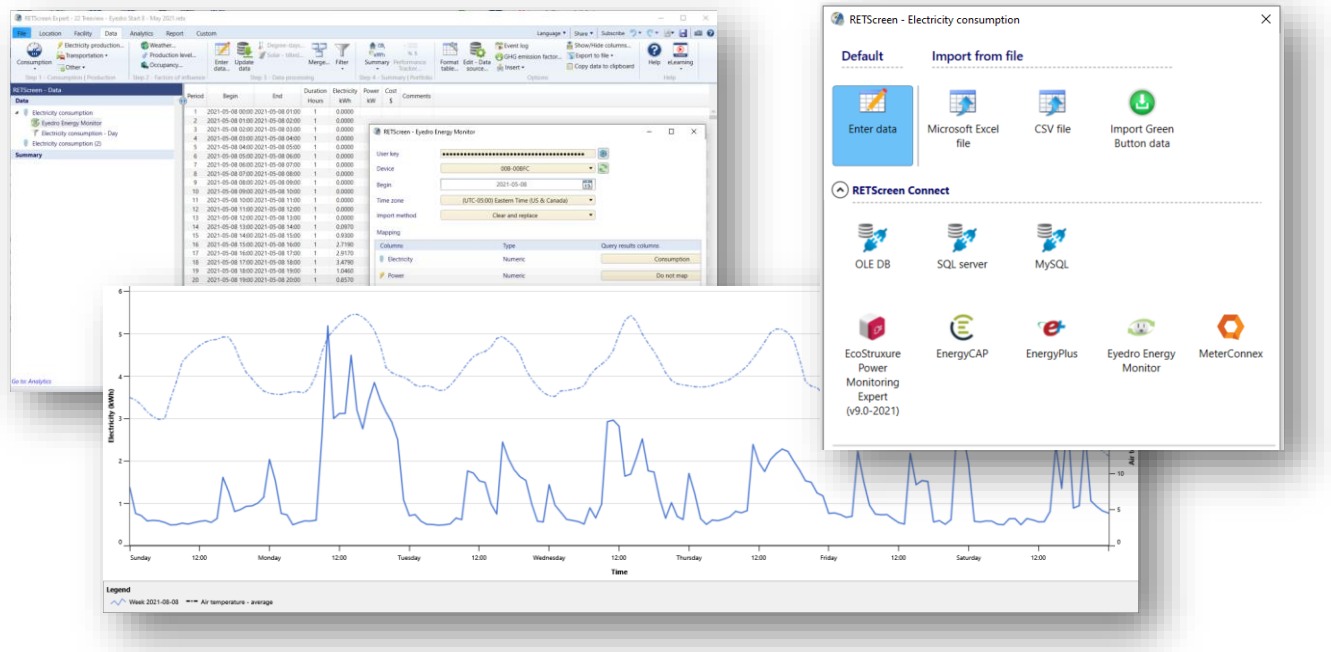


Use load duration curve to analyze





RETScreen Expert can interface with metered data



Real world example

A load shedding and load shifting strategy

Case 1: commercial facility – Class A customer

- Case study provided by Energy@Work
- 900,000 ft2 commercial building
- Large chilled water storage tanks, electric boilers and gas boilers
- Perform both load shifting and load shedding

Global adjustment actions

The following are actions that an operator should take during load shedding:

1. Switch off hot water tanks
2. Increase chilled water temperature
3. Turn off chillers – rely on storage tanks
4. Reduce pump speeds by 5% by lowering differential pressure (DP) setpoints
5. Turn off non-essential lighting and dim others to 70%
6. Turn off non-critical loads such as SF13, SF58, SF62, SF18, SF82
7. Move all variable air volume (VAV) setpoints to their upper values (typically 76°F)

At the end of event:

1. Bring the systems and chillers back slowly, if needed, while not exceeding pre-programmed monthly peak

General peak demand management

Sequential order of steps as peak demand approaches its maximum setting (not GA-related):

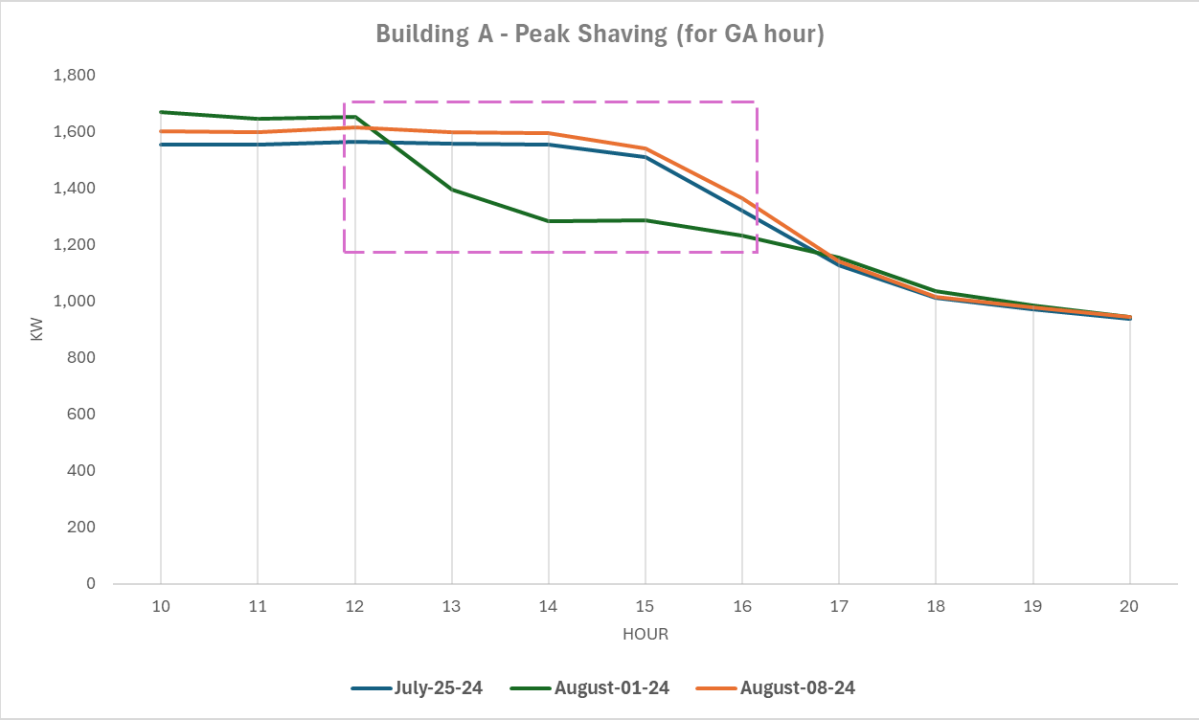
1. Modulate electric boilers and supplement with natural gas during winter

When electric boilers are off:

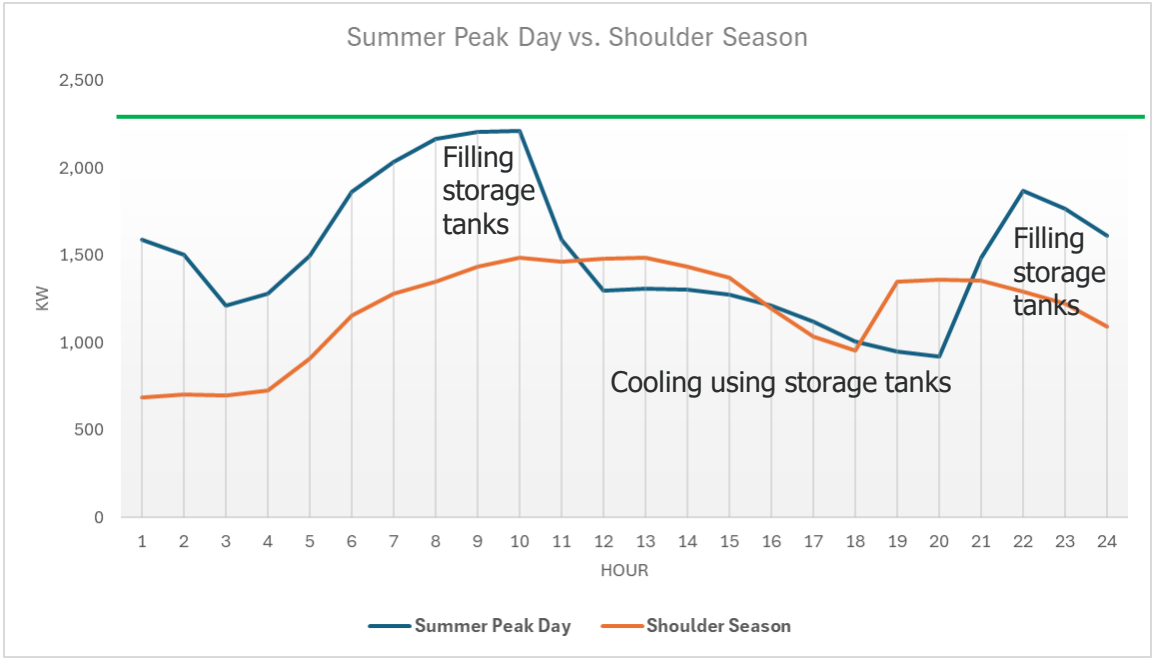
1. Turn of hot water tanks
2. Reduce static pressure of the essential supply air fans: SF46, SF45, SF7, SF57, SF59
3. Turn off non-essential fans: SF62, SF58, SF18, SF66, SF5
4. Adjust compartment fans reducing pressure differential set point
5. Turn off non-essential lighting (back of house) and dim others to 70%
6. Increase chilled water temperature
7. Move all VAV setpoints to their upper values (typically 76°F)

**The supply fans numbers are for example purposes only*

Example of demand profile for load shedding



Example of demand profile for load shifting



Maximum peak set point

Results

- Using the effective electricity rate in which both load shaving and load shifting are accounted for, this facility achieves an impressive blended rate of $0.09/kwh compared to an estimated $0.14/kwh for similar buildings in the area.
- Total cost avoidance is estimated at close to $800,000

Case 2: industrial facility – Class A customer

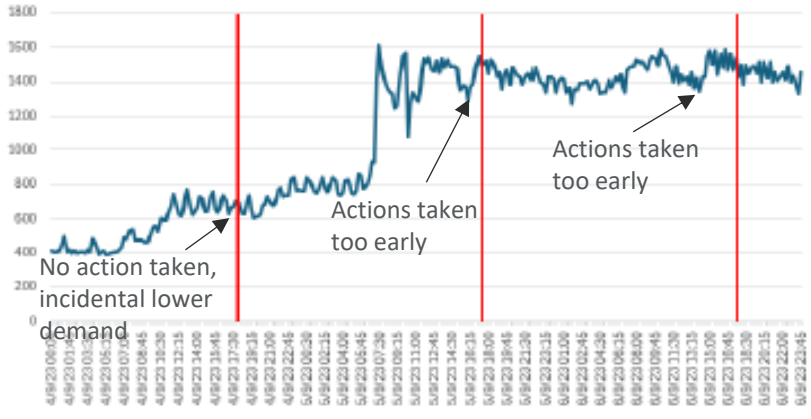
- Uses an external service for GA alerts
- Programmed a series of actions in the BAS
- Measures in the BAS:

1. Increased cooling setpoint
2. Turned off some rooftop units (RTUs)
3. Reduced lighting in non-production areas
4. Turned off some battery chargers – centrally controlled

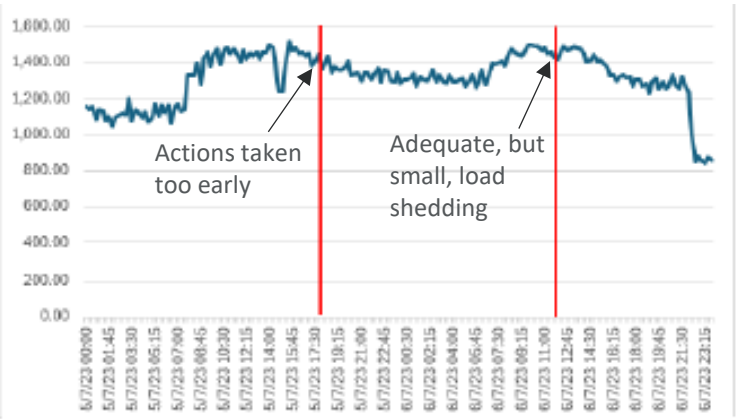
Load shedding for GA curtailment

- Missed four of five GA occurrences – commissioning (Cx) of logic/sequence is crucial!

GA hours in September



GA hours in July



Impact of inadequate load shedding

- Net average increase of 50 kW due to improper commissioning and mistimed enabling of the load shedding sequence.
  - Slight increase due to the rebound effect
- Based on the possible observed reduction, the net annual cost impact of the noted deficiency is $75,000.

The rebound effect is defined as the simultaneous switching on of equipment/devices after having been switched off for a prolonged period due to a peak load reduction event.

In summary - demand management and BAS

- Ensure the BAS has real-time demand available
- Set your goals and familiarize yourself with your usage profile
- Identify equipment and processes that can be part of load management
- Size, duration - make sure you know the impact of load shedding/shifting and the procedure for getting the equipment back up and running to avoid creating a new peak!
- Program and test the BAS sequences
- Track on a continuous basis – one slip can be costly!

Questions and answers

- Any questions?
- Training and support webpage: visit this page to access all training and support materials

Post-Webinar Support

One-on-one coaching: tailored support for managing energy resources effectively

Post-webinar support intake form

Coaching sessions conducted virtually: phone, video calls and email

Designed for organizations, new or old, seeking guidance

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Save on Energy's Capability Building Program

- Save on Energy's Capability Building Program helps increase awareness about energy-efficiency opportunities, enhances knowledge and develops skills in organizations and communities across Ontario so they can undertake energy-efficiency actions and participate in Save on Energy programs.
- The program includes tools such as workshops, webinars, training courses, coaching, peer learning and information resources, including guides and videos.

Learn more at
https://saveonenergy.ca/Training-and-Support
Register at
www.saveonenergytraining.ca

Training courses – incentives

Save on Energy offers incentives of up to 50% for ~20 training courses, plus certification exam fees, including:

- Achieving Net-Zero Buildings
- Energy Management and the ISO 50001 Standard
- HVAC Optimization for High Performance Sustainable Buildings
- Certified Energy Manager (CEM)
- Certified Measurement & Verification Professional® (CMVP)

Learn more at https://saveonenergy.ca/Training-and-Support/Training-Courses

Training courses – incentives for Enbridge customers

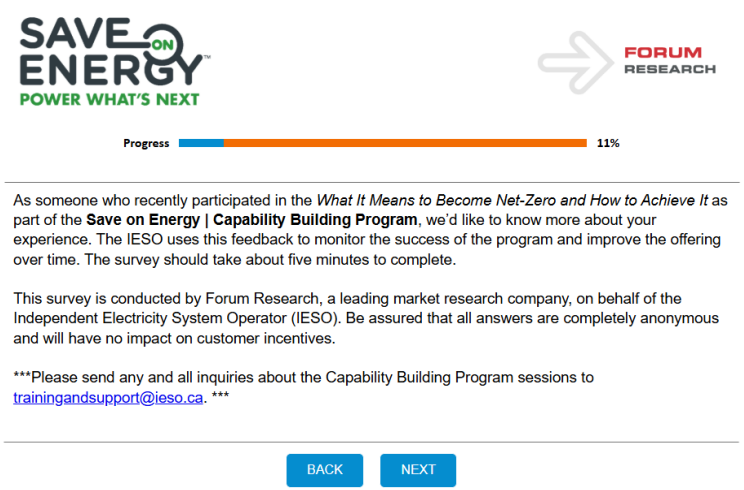
Enbridge customers are eligible for incentives of up to 75% for three courses:

- Dollars to $ense Workshops: up to $500 a day
- Certified Sustainable Building Operator® (CSBO): up to $2,250 of course fees
- Certified Energy Manager® (CEM): up to $2,500 of course fees

Stay connected with tools and resources

- Virtual one-on-one coaching: post-webinar support intake form for tailored support for organizations to manage energy resources effectively
- Monthly bulletin: sign up to receive monthly training updates on all Save on Energy training and support new tools and resources
- Live training calendar: visit this page to easily register for upcoming events and workshops
- Training and support webpage: visit this page to access all training and support materials

Upcoming survey: we want your feedback!



- Check your email! A survey is coming your way soon.
- Why? Help us improve our training programs.
- Who? Conducted by Forum Research on behalf of the IESO.
- Time? Takes only five minutes to complete.
- Confidentiality: Your responses are anonymous and won't impact participation or incentives.

The survey will be sent from:
surveyinfo@forumresearch.com

Thank you!

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