NOVACAB'S Flagship Green Energy Storage Project

The Montreal Stock Exchange

Every Green Energy

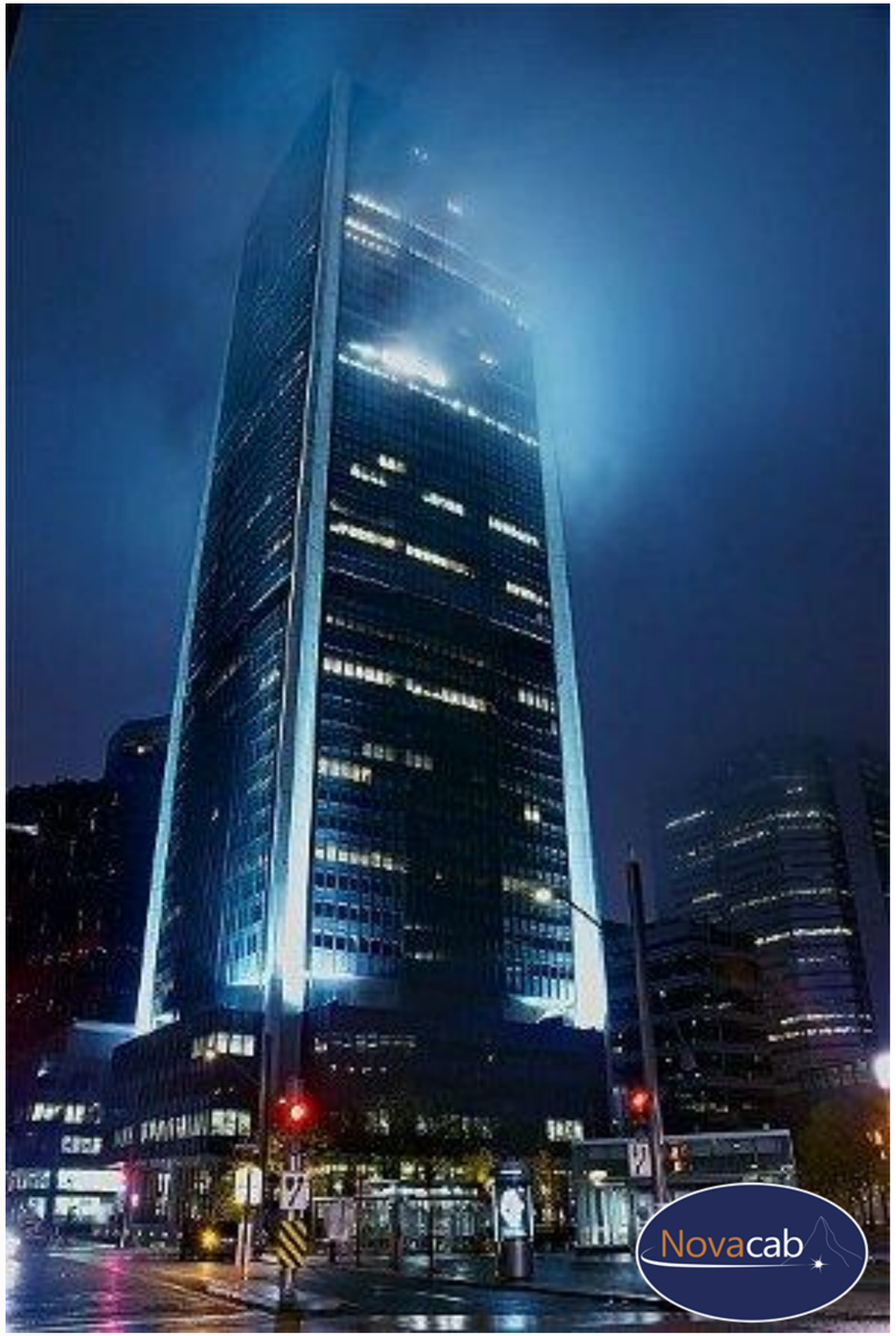
Company wants to have a Trophy Property

Novacab

NOVACAB has theirs!

The 48-Story Montreal Stock Exchange….

With 2 Levels of Data Center Space

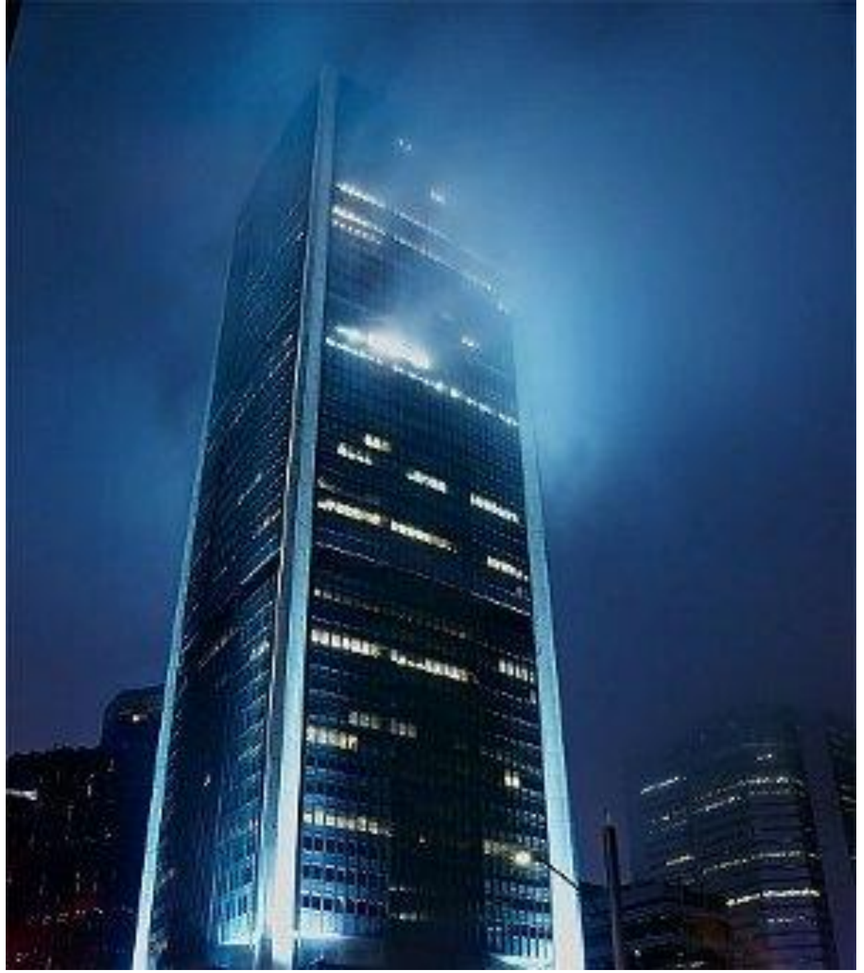


The Amazing thing is the RESULTS produced by NOVACAB.

40% SAVINGS

in Energy Spent for Cooling!

Novacab



Let's take a look at the technical side of this Project....

Novacab

The Montreal Stock Exchange Case Study

Thermal Energy Storage System

Excerpts from Operation & Monitoring Report Of a Multi-Functional Office & Commercial Building with Data Center

The 48-Story Montreal Stock Exchange

IMPLEMENTATION 2009 – Montreal Stock Exchange Tower
In collaboration with JOHNSON CONTROLS

2 Large Data Centers: Critical Operation 24/7

- 48-Story High-Rise Building
- Building Area: 1,076,690 sq. ft.
  - Institutional and Commercial Use
  - Office, Retail & Public Spaces
- 2500 Tons of Installed Cooling (Chillers)
- Novacab TESS Units Deployed:
  - 13 Units for Efficiency, 5 Units for Back-Up

The Montreal Stock Exchange

Novacab

How the Building was Operating Before Novacab

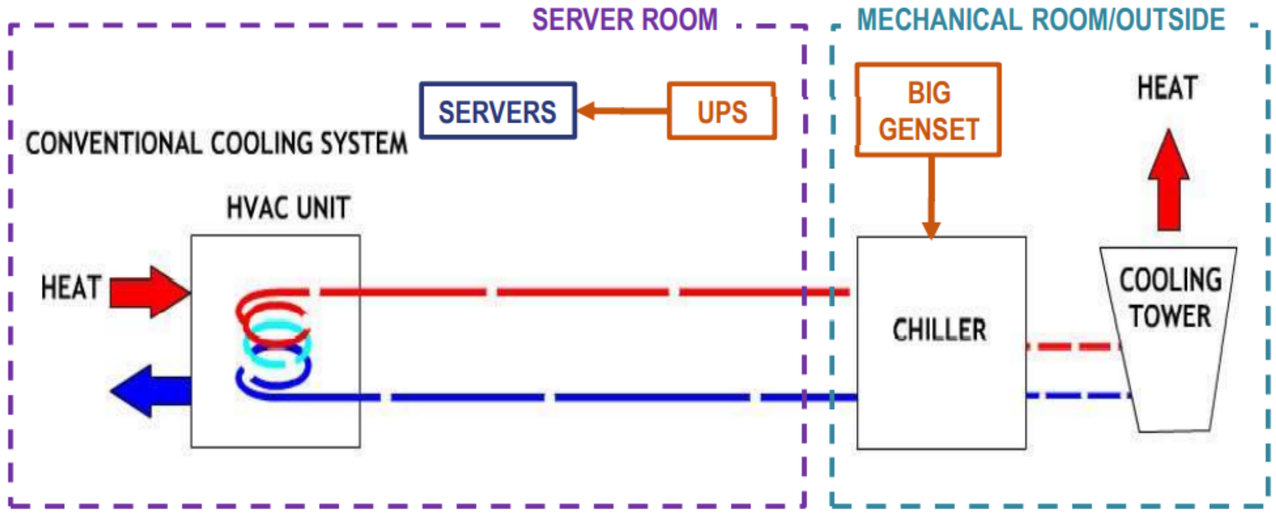
The chiller plant generates chilled water for the computer room HVAC units, and heat is rejected outdoors through a cooling tower (Wasted Heat)

- The hotter the outside temperature, the harder the chiller and tower must work; and the greater the load is on the electric grid

- The Chillers must account for all such extreme conditions

- The Variability in Cooling Load leads to partially-loaded, inefficient chiller operation

- No monitoring/controls were in place to optimize the operation

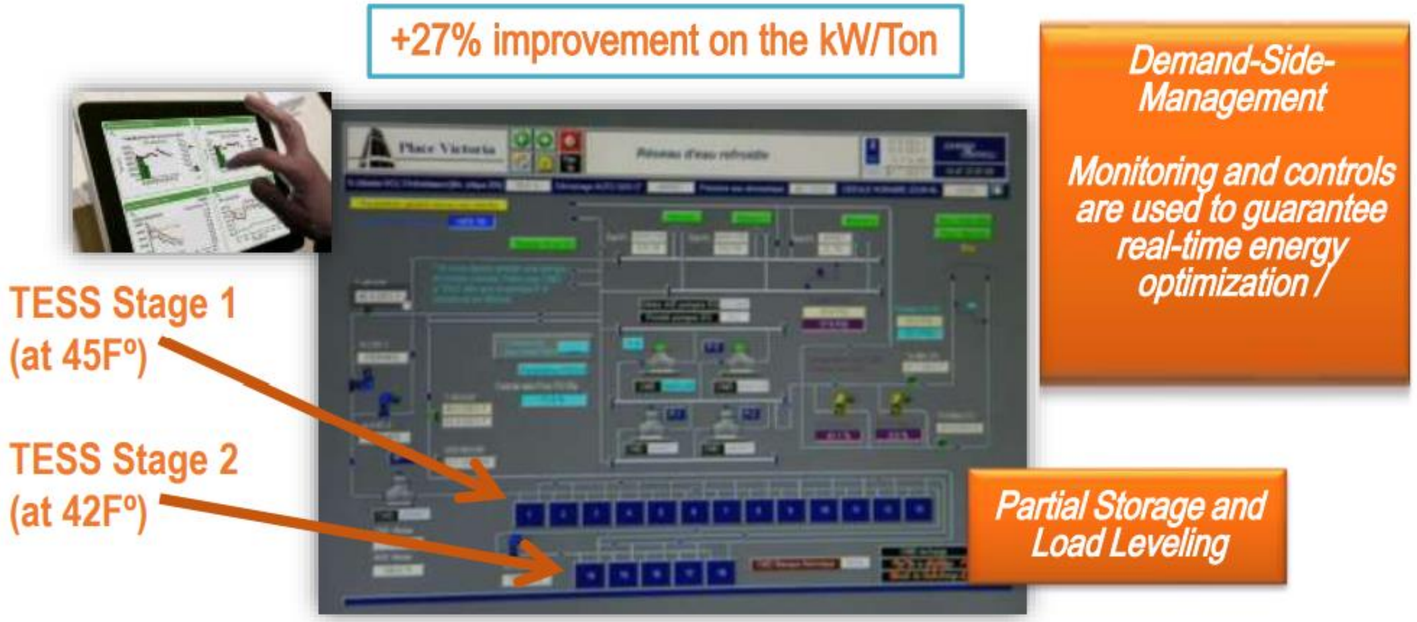


Operating Improvement AFTER Novacab

Operating Improvement AFTER Novacab.

• TESS Units are "Charged" during off-peak hours when the outside temperature is more favorable and using the grid when it more effective.

• TESS Units are “Discharged” during peak hours absorbing transient increases in data center cooling load and avoiding startup of additional chillers, thereby reducing the load on the grid during peak hours.

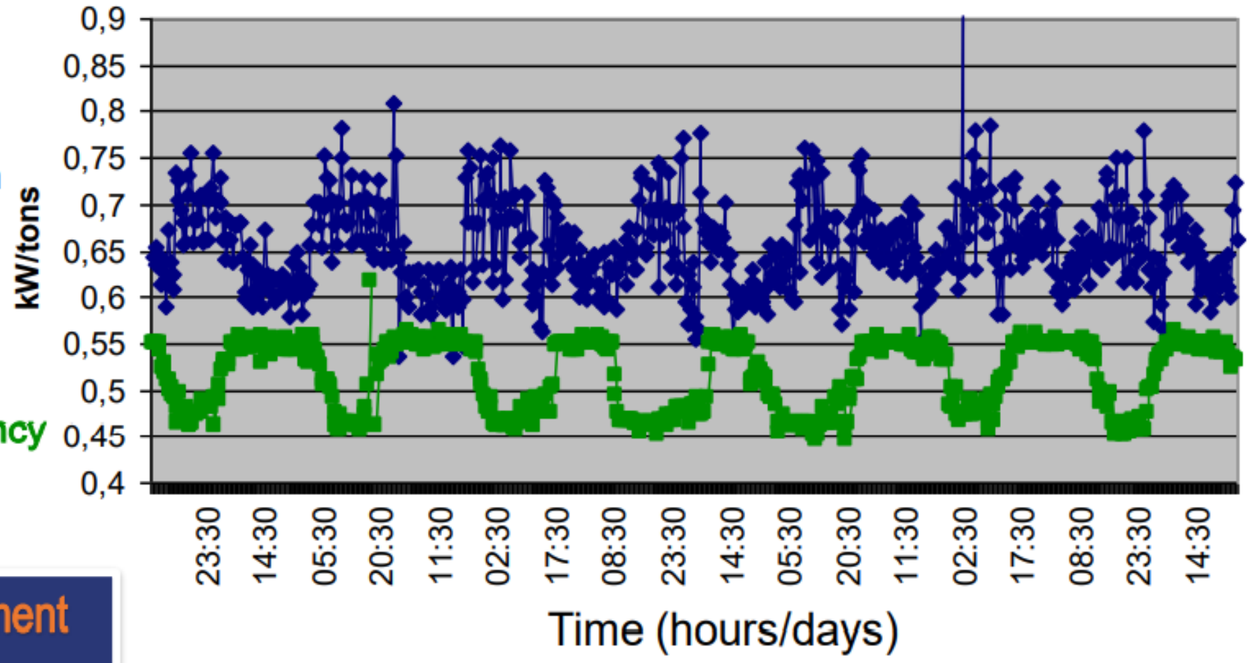


Excerpts of Data from Independent Operational Monitoring Report

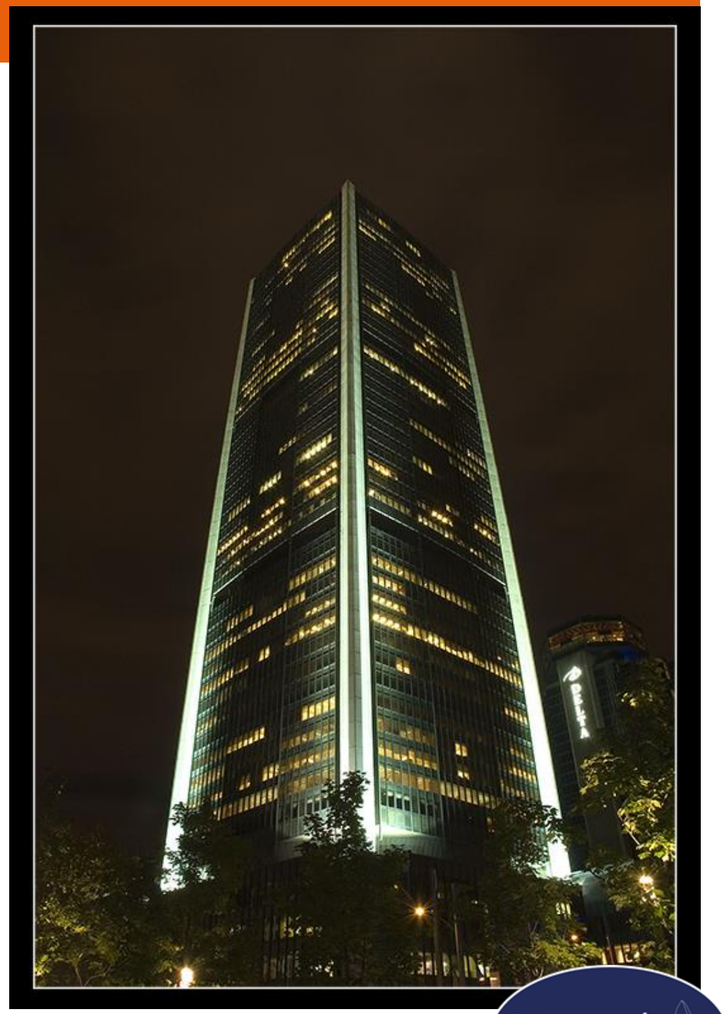
Chart shows Efficiency of Chillers BEFORE and AFTER the Installation of Novacab TESS Units

BEFORE Installation:
High Fluctuations, with
Low Efficiency

AFTER Installation:
Reduced Fluctuations
with ***Increased Efficiency***

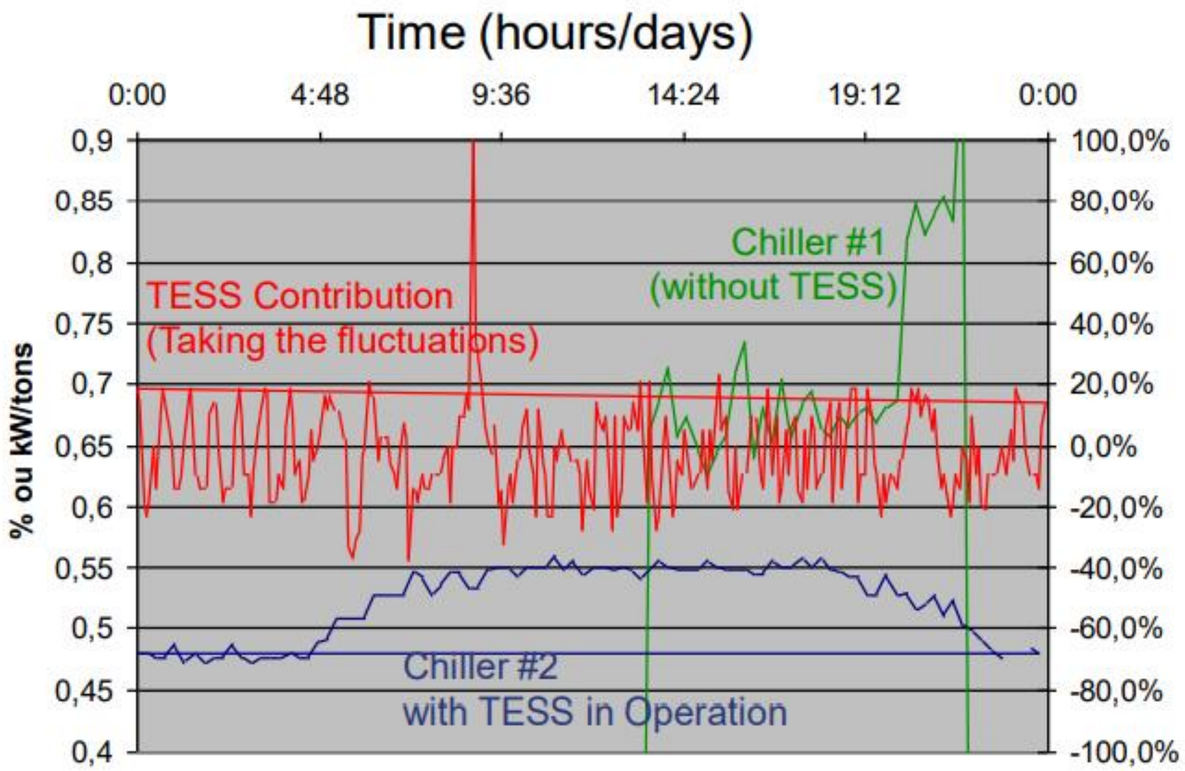


+27% improvement on the kW/Ton



Novacab

Excerpts of the Data from Independent Operation & Monitoring Report

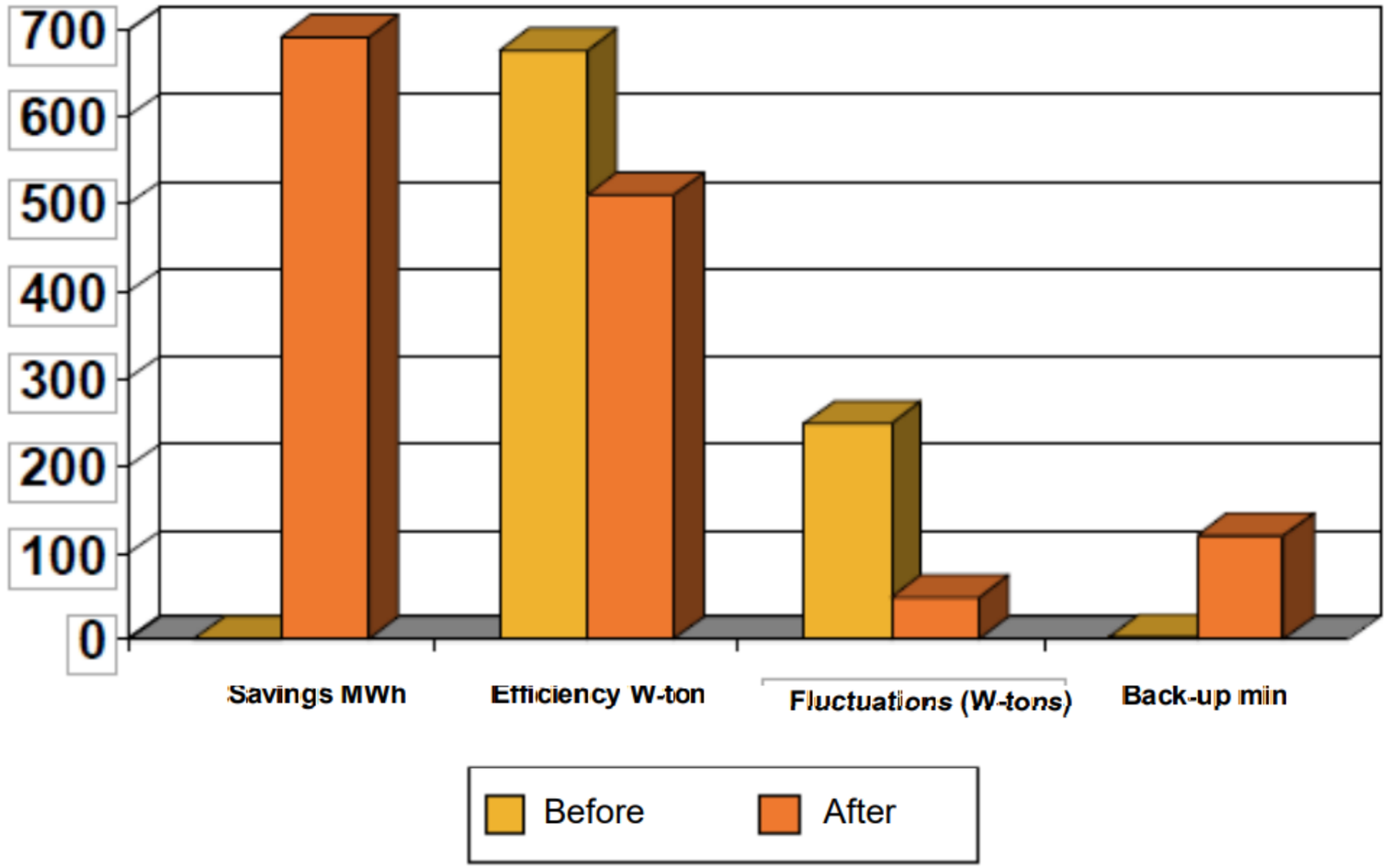


Role of the thermal storage ; absorbing high fluctuations

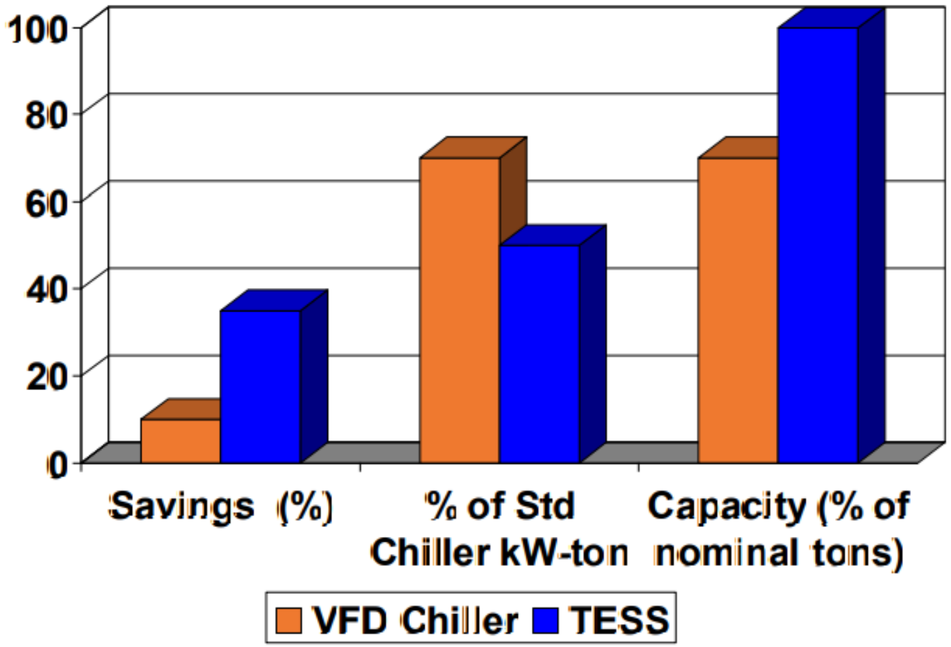
Impact on Chiller #2 ; small fluctuations and improved efficiency

Impact of Novacab TESS Units on Energy Savings and other Energy Impact Factors at the Montreal Stock Exchange Tower

- Dramatic Savings - Improved Efficiency - Reduced Fluctuations - Backup Capacity



Impact of Novacab TESS Units on Energy Savings and other Parameters for Chilled Water production with VFD alone and after Novacab TESS Installation



Highlights:

- Higher savings
- Increased efficiency
- Higher capacity

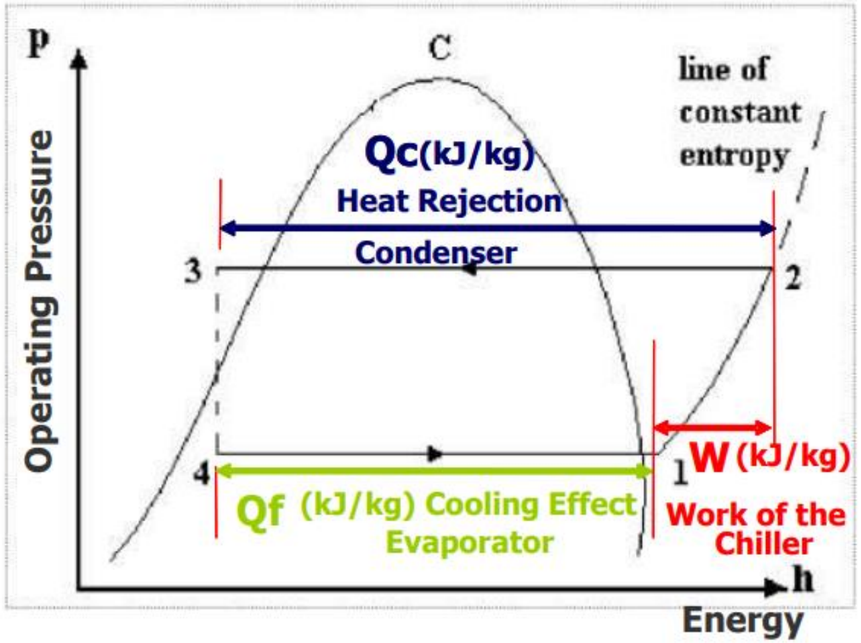
Control Strategy Parameters Thermodynamic Justification

The Novacab system allows for the Optimization of the Thermodynamic Cycle

❑ Operational savings (Central Chiller configuration):

- Reduced Maintenance because of :
  - Reduced stops and starts
  - Reduced ramp up/ramp down – reduced short-cycles
  - Reduced average condensing pressure (temperature)

❑ Secured supply of chilled water in case of mechanical or electrical failure (as a back-up)



Coefficient of Performance (COP)

$$COP = \frac{\text{Useful Effect}}{\text{Paid Energy}}$$

$$COP = Qf / W$$

COP *AFTER* > **COP *BEFORE***

With TESS — Without TESS

Impact of TESS on Chiller Capacity and Efficiency

Constant Speed + Free Cooling + Thermal Storage ≥ Variable Speed (VFD)

700 tons Chiller + Thermal Storage ≥ 1 200 tons Chiller

Energy Savings at the Stock Exchange Tower

Partial-storage/load-leveling Novacab TESS operating strategy:

❑ In the partial-storage approach, the mechanical equipment runs to meet part of the peak period cooling load, and the remainder is met by drawing from storage.

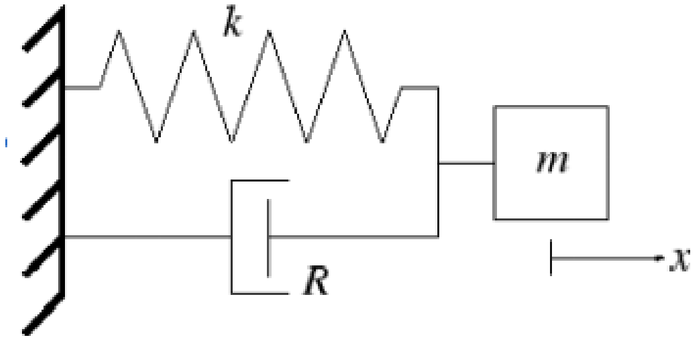
❑ The fluctuations in the cooling load are taken by the thermal storage tanks.

❑ Ramp-up and Ramp-down of the mechanical equipment are reduced.

❑ Supply and Return temperatures are stabilized close to the design set point.

❑ The TESS units are acting as "shock absorbers" in the chilled water loop.

❑ In the load-leveling phase, the equipment runs at its full capacity for 20 to 24 hours on the design day. When the load is less than the equipment output, the surplus energy is stored. When the load exceeds the capacity, the additional requirement is discharged from storage. A load-leveling approach minimizes the required equipment and storage capacities as well as GHG emissions for a given load.



Outcome Summary

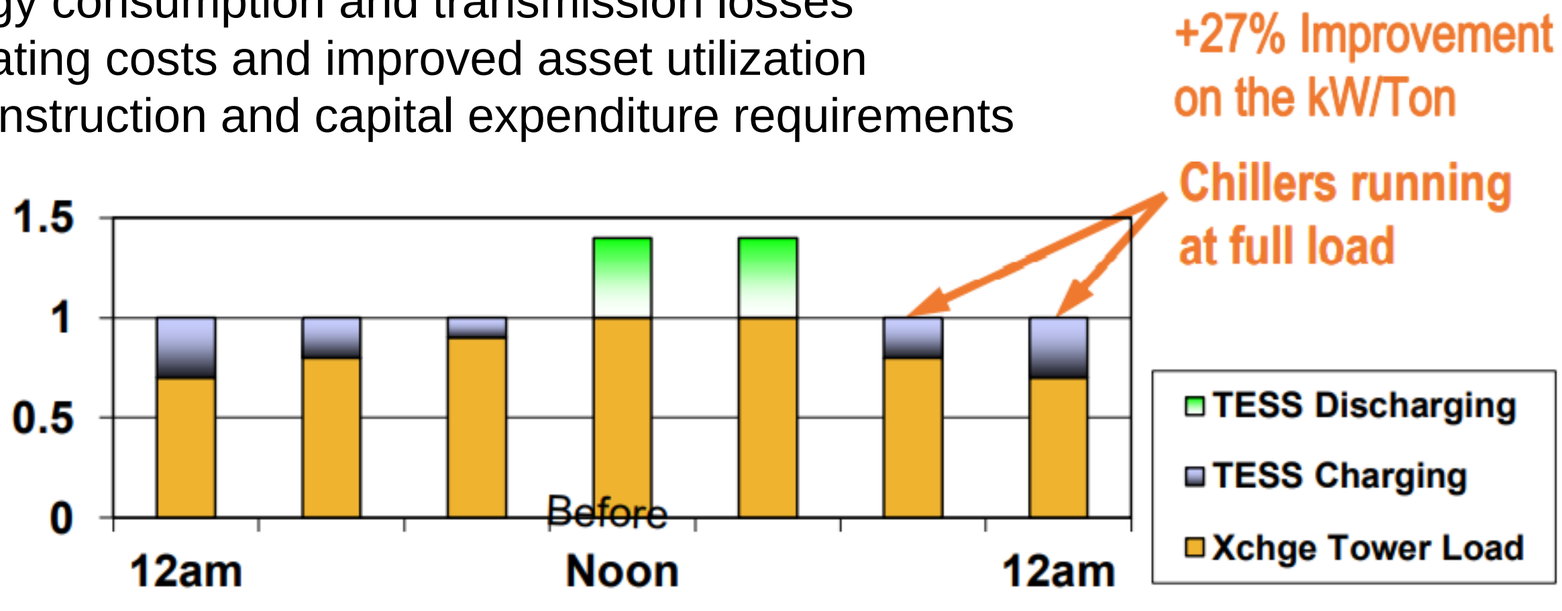
MEASURED OPERATIONAL COST SAVINGS OF TESS

Monitoring has shown that the largest outcomes are obtained when fluctuating conditions are observed and eliminated.

- Reduces Peak Loads (kW) and Energy Consumption (kWh)
- Energy Efficiency, incremental peak shaving, boosted free cooling
- Minimizes Stops & Starts, Overdesign, and Part Loads

By smoothing the load profile Novacab optimizes demand-side management allowing for redundant and predictable energy distribution.

- Lower energy consumption and transmission losses
- Lower operating costs and improved asset utilization
- Deferred construction and capital expenditure requirements



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