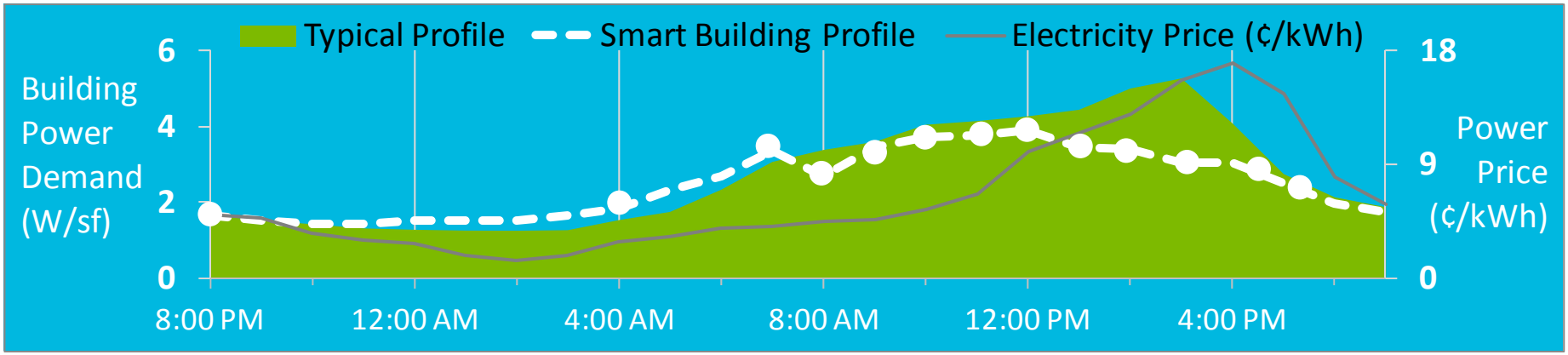
Smart Buildings for a Smart Grid

A Day in the Life

How the **smart grid building manager** will create business value in, for example, a 50,000 sqm tenant-occupied office building on an hourly real time electricity pricing tariff



Johnson Controls

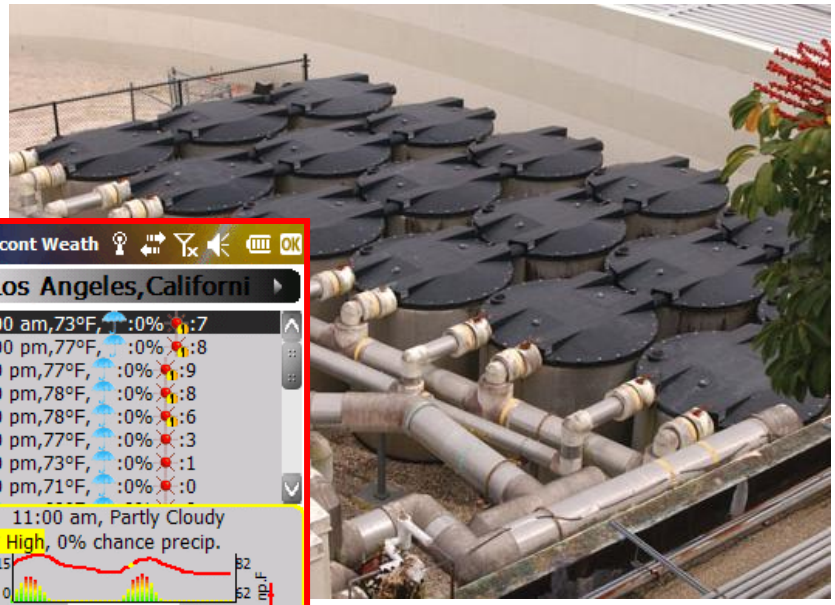
8:00 pm

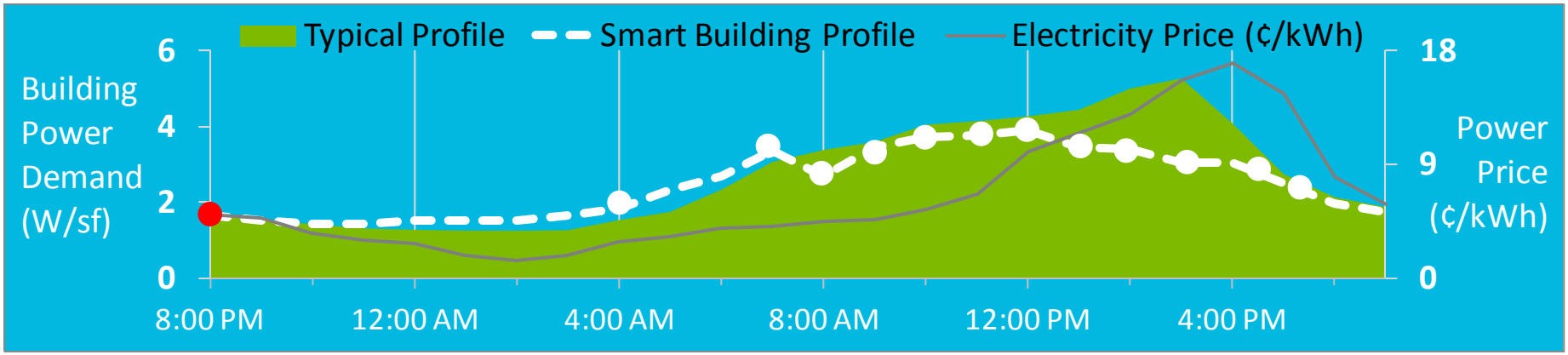
Smart planning for tomorrow

System accesses tomorrow's weather forecast from local weather station and models the building's hourly load profile

Real time price forecasts are received from the electric utility

Based on predicted high afternoon temps and prices, system schedules night time ice storage generation to take advantage of low night temps, improved efficiency, and off-peak prices





Johnson Controls

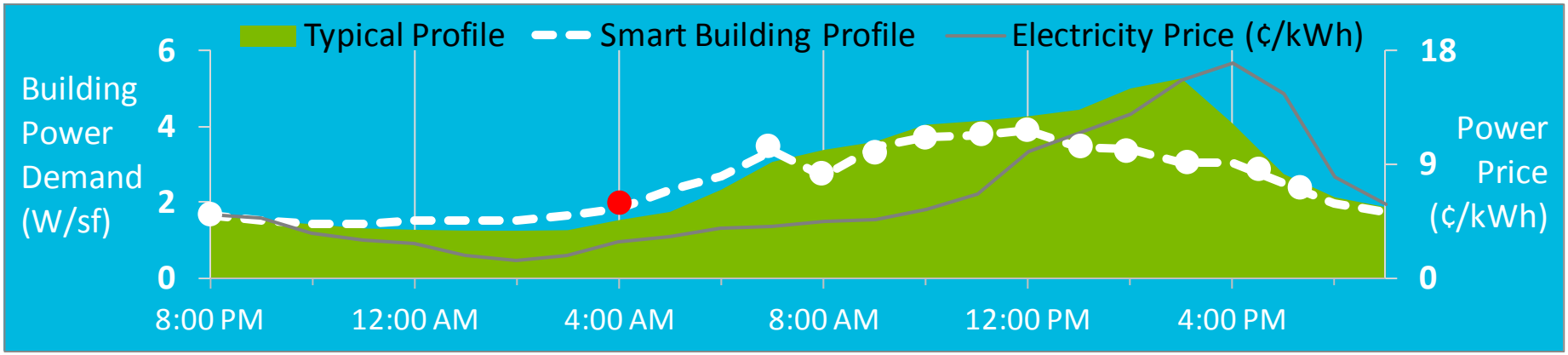
4:00 am

Chiller fault detected

During night time ice generation, the diagnostics engine determines a chiller valve has failed, resulting in a reduction in glycol flow, system efficiency, and ice storage charging speed

System calculates costs associated with this fault based on real time price forecasts

Due to the high projected cost impact, the system auto-generates a work order and notifies facility manager by smart phone for approval



Johnson Controls

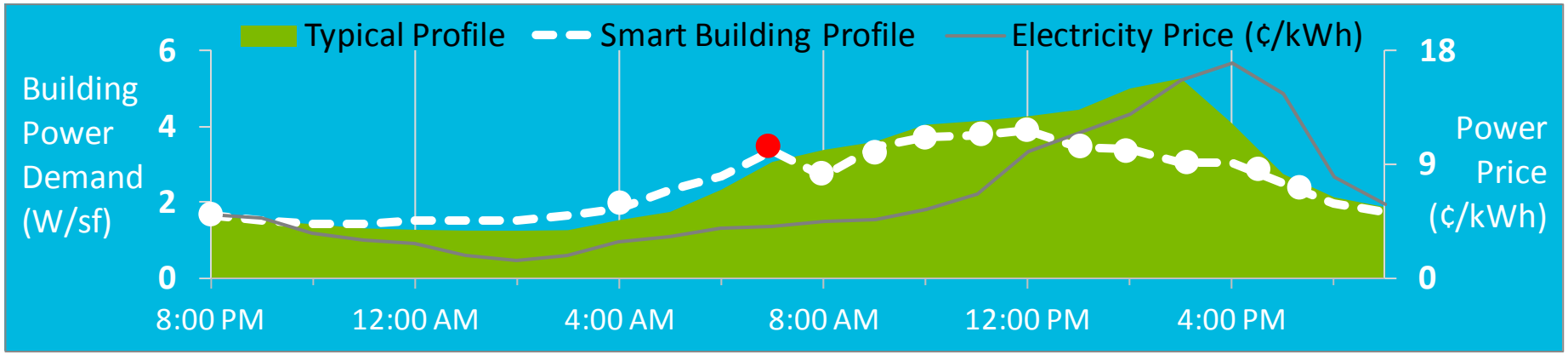
7:00 am

Chiller repaired

Service technician arrives after being dispatched automatically upon facility manager's approval

Technician quickly fixes problem knowing the source and the new parts required (e.g. a new transformer for the spring return valve)

Repair results in immediate load reduction and increase in ice tank charge rate. Allows system to generate enough ice prior to spike in prices anticipated later in the afternoon



Johnson Controls

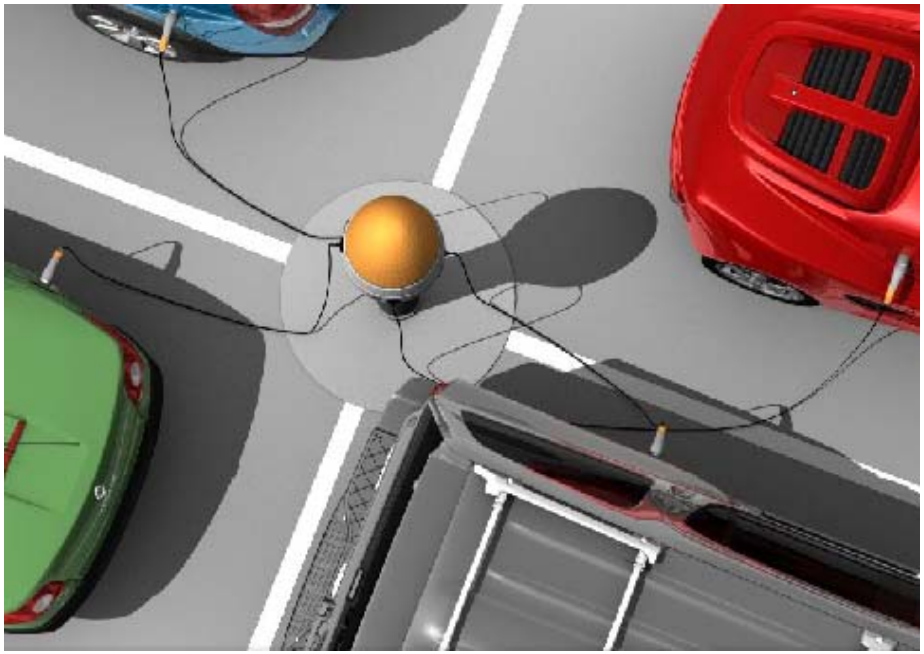
8:00 am

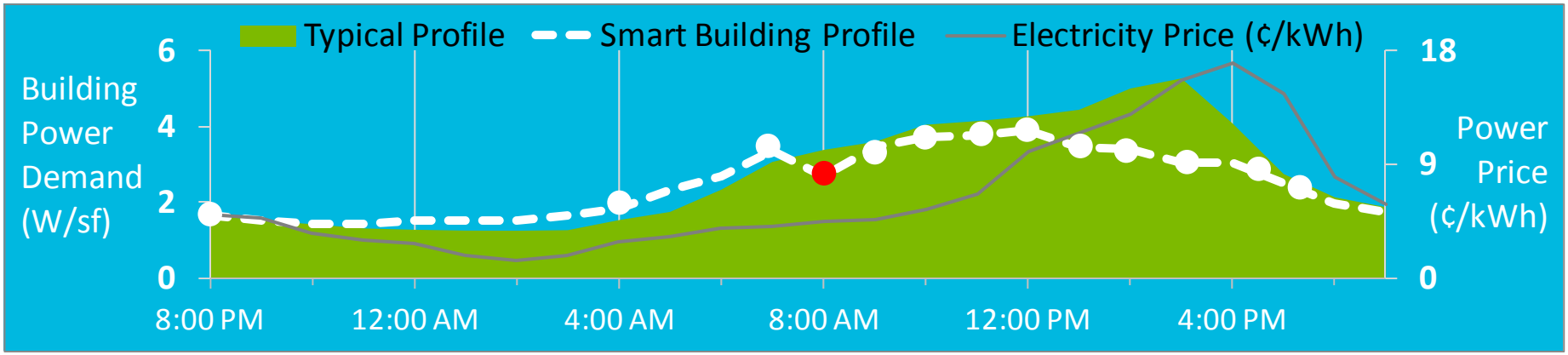
Employee plugs in vehicle at work

Electric or plug-in hybrid vehicles recharge when real time price of electricity is low or when onsite solar photovoltaic system's power production is high

Smart charging can also support voltage regulation for the local utility

Purchase or sale of power to building is automatically factored into payroll system





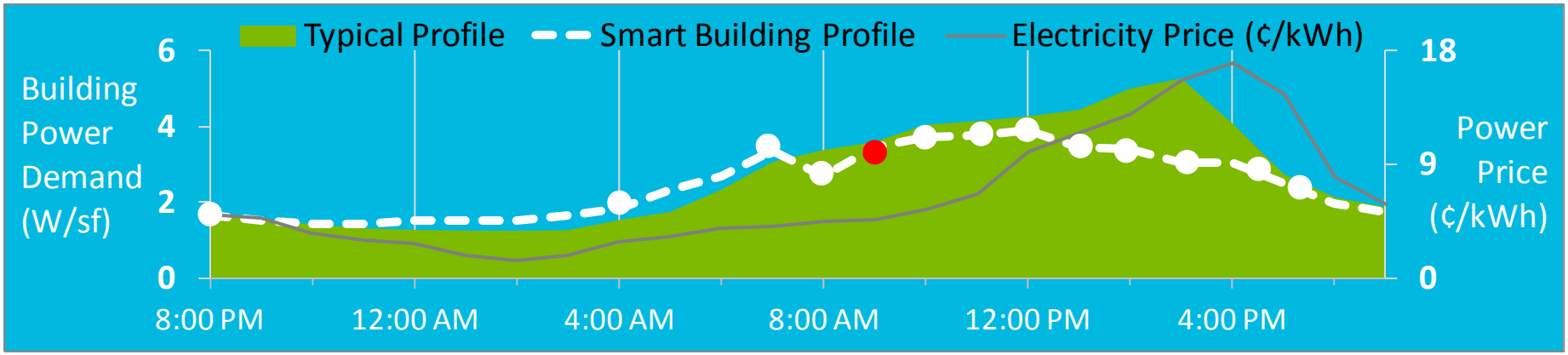
Johnson Controls

9:00 am

Meeting space is ready to go

Based on integration to Tenant A's conference room reservation system, the conference room environment is optimally prepared for a meeting with 15 people

Occupancy and CO_2 sensors provide an override to save energy in the case of a no show, or to ensure comfort in case more attendees end up joining the meeting



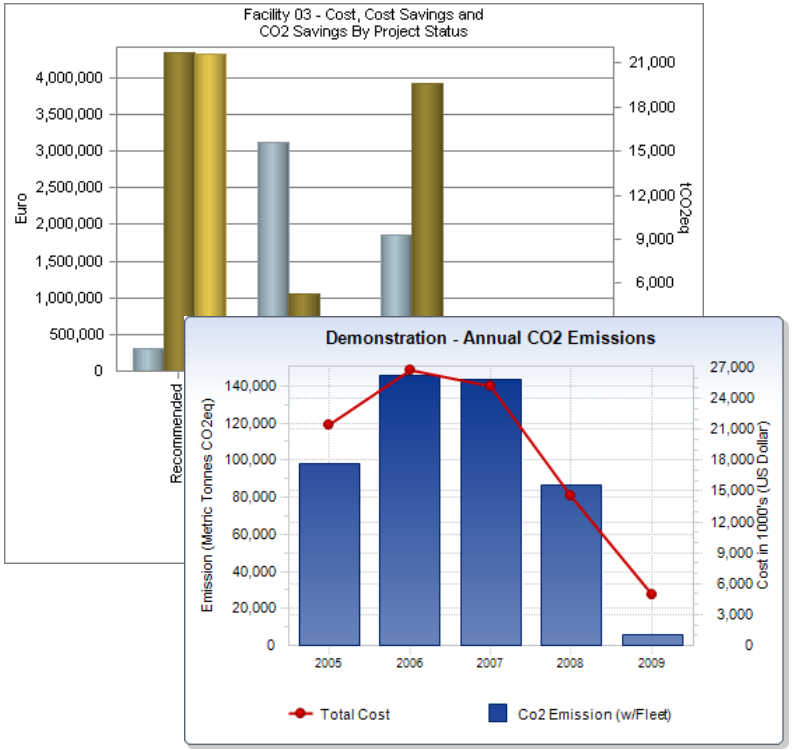
Johnson Controls

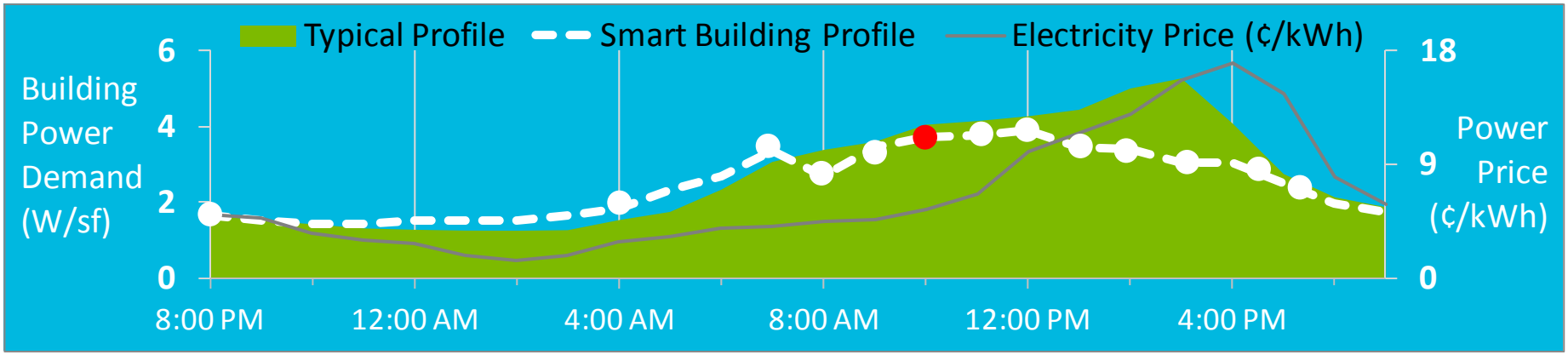
10:00 am

CFO calls for carbon reporting data

A market analyst firm has posed questions to a CFO about the business' carbon risk and strategies that have been implemented to reduce the greenhouse gas intensity of the economy

At the click of a mouse, real estate executive pulls up data in an enterprise application dashboard for carbon emissions for the most recent quarter and the verified carbon reductions the organization has achieved through programs and projects





Johnson Controls

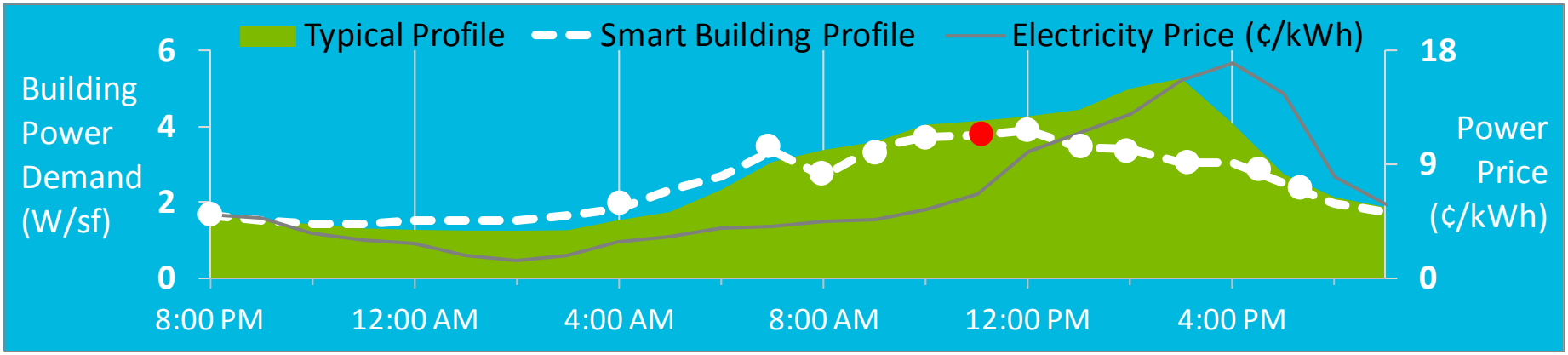
11:00 am

Utility power price triggers automatic demand reduction for tenant

The price for 12pm-2pm received from the utility exceeds the threshold pre-defined by the tenant, triggering the following actions to reduce power demand for that time period.

- reset space temps by 2°F
- reset static pressure of air terminal units
- slowly dim lighting 20% in occupant spaces

Actions and impact reported back to utility



Johnson Controls

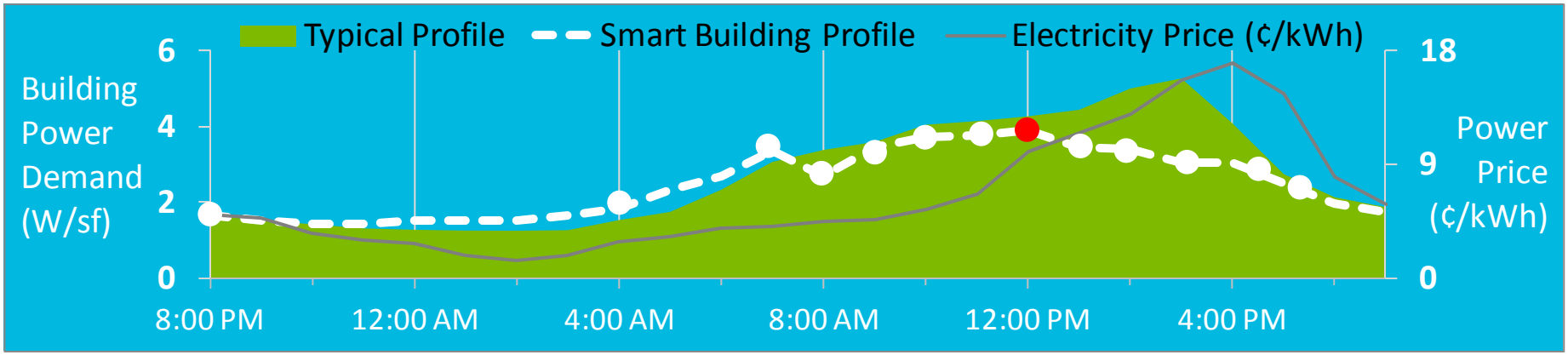
12:00 pm

Power price triggers automated demand reduction for building owner

Like the tenant, the real time prices from 12pm-2pm exceeds the pre-defined threshold for the building owner triggering power reductions in the central plant and common areas, including:

- dispatch ice storage cooling
- increase chilled water set point
- dim lighting in common areas by 20%
- variable frequency drive limiting

Actions and impact are reported back to utility



Johnson Controls

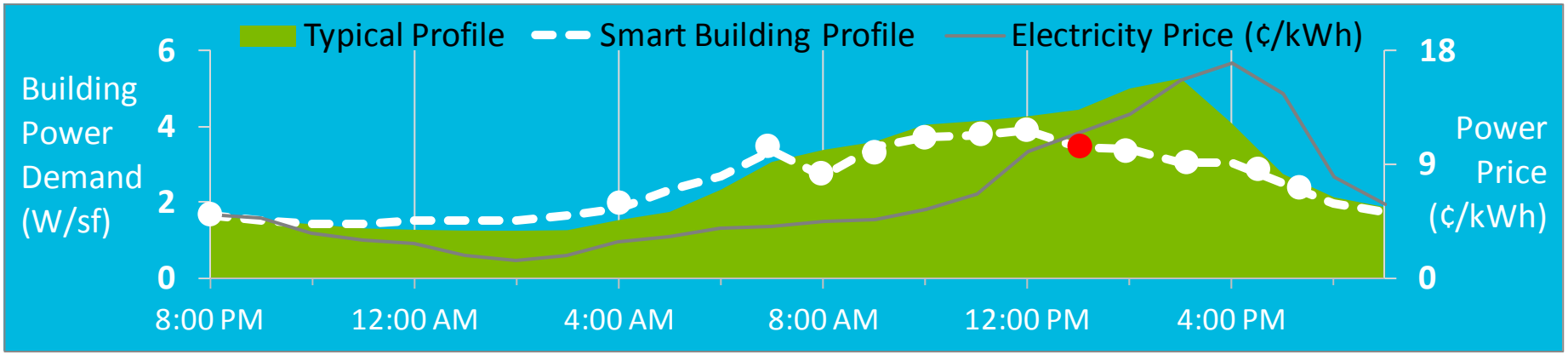
1:00 pm

Power price triggers triggers more aggressive automated reductions for tenant.

The real time price for 2pm-5pm from the utility well exceeds the defined threshold for the tenant triggering more aggressive power reductions, including:

- dim lighting by 40%
- reset space temps by 4°F
- throttle non-production servers

Actions and impact reported back to utility

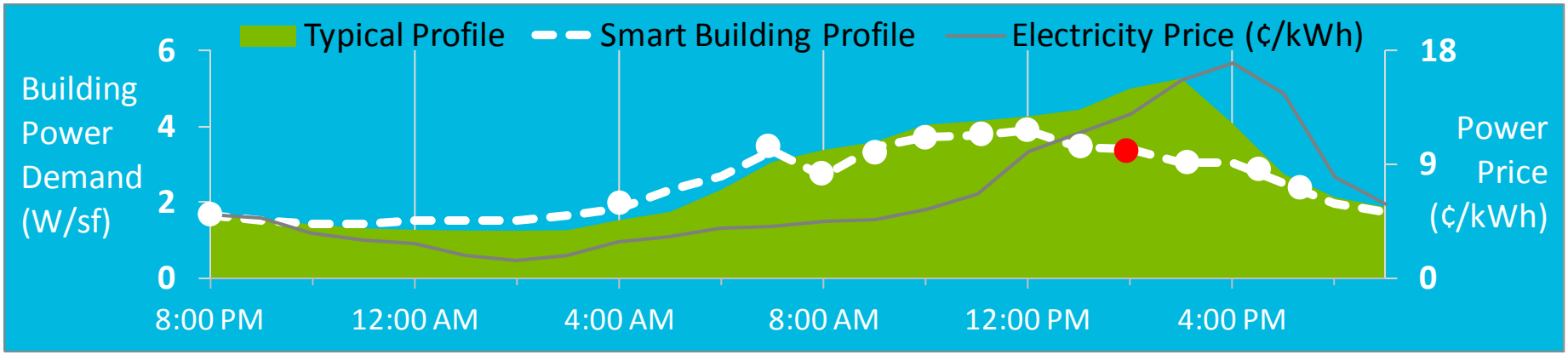


Johnson Controls

2:00 pm

Automated demand reductions leverage IT system integration

System alerts employees via email or instant message to unplug their laptops or automatically uses PC power management software agent so that laptops run on battery power from 2-4pm



Johnson Controls

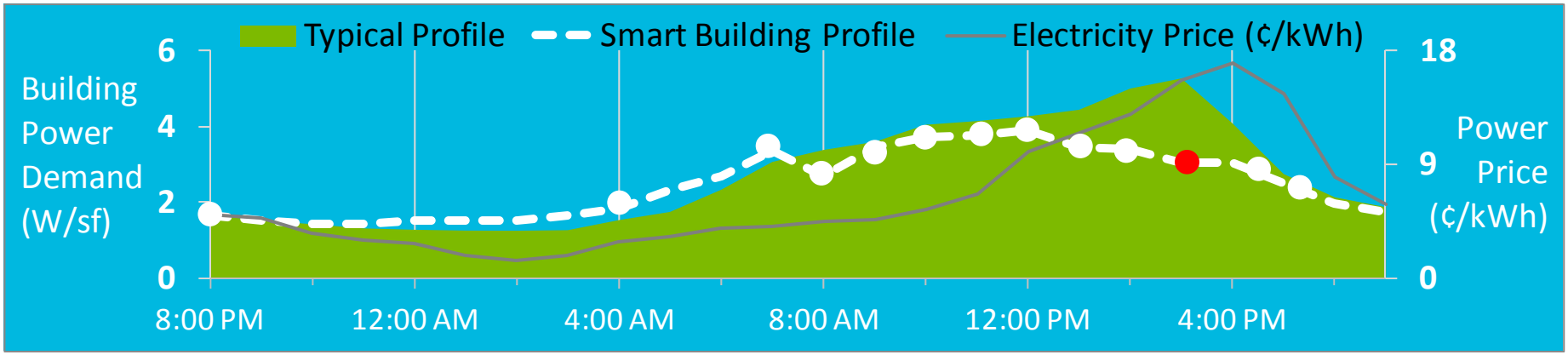
3:00 pm

Cloud cover causes solar photovoltaic generation to drop

Building owner received a demand limiting signal from utility to use no more than 1.5 MW during the 2pm -5pm period.

Building is relying on power from rooftop solar photovoltaic system to meet some load beyond that 1.5 MW being drawn from the grid.

When cloud cover causes solar production to drop, system dispatches onsite electric storage to meet contract obligations with utility.



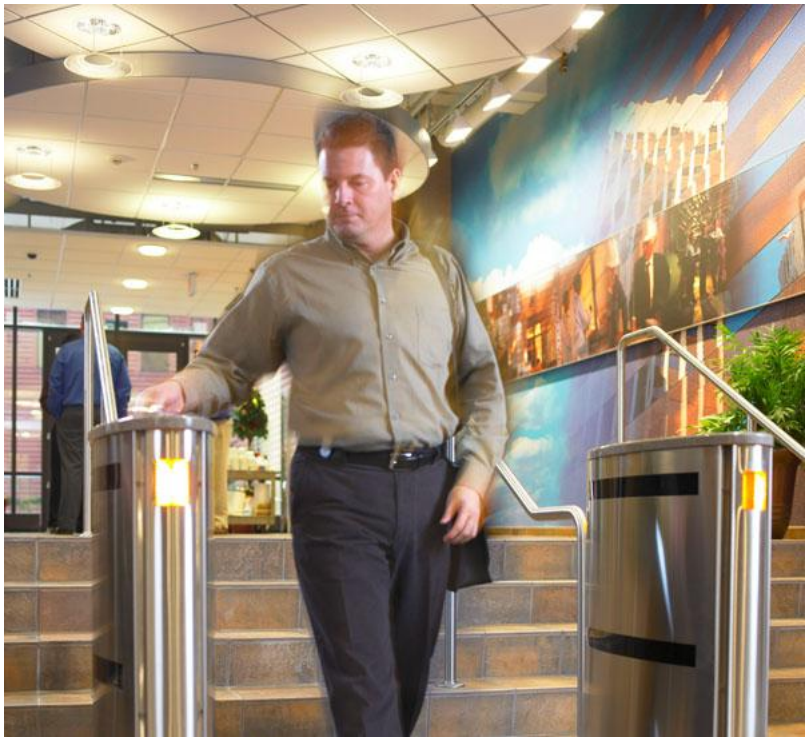
Johnson Controls

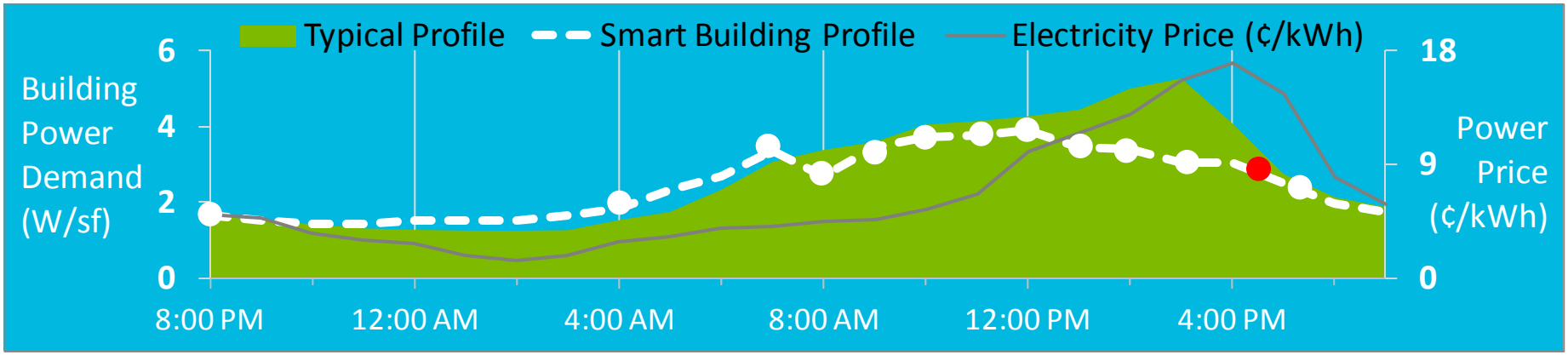
5:30 pm

Leaving the office

As employee badges out, the system recognizes that he forgot to turn off the lights and desktop computer in his office. It automatically turns off the lights and puts the computer into its lowest power stand-by setting

When he arrives to parking deck, his plug-in electric vehicle has been charged (during the low-price hours) enough for him to get home





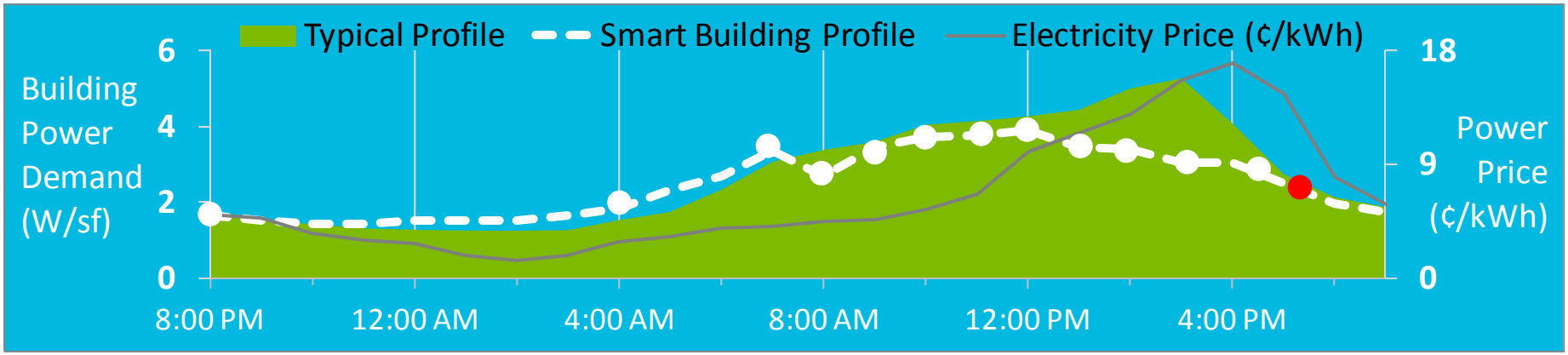
Johnson Controls

6:30 pm

End of the workday

System controls lighting and HVAC to follow janitorial staff in order to maximize convenience while only lighting the occupied spaced in building

Video surveillance system counts occupants remaining in each part of the building after hours and adjusts zone set points and lighting accordingly



Johnson Controls

Case Study: Georgia Institute of Technology

- Georgia Tech buys electricity on dynamic hourly price from Georgia Power
- Each hour, building management system reads prices for for next 48 hours from utility's web service feed
- Facilities director sets price threshold for automated load shedding mode

Savings during initial summer 2006 single building pilot

Week	Number of RTP Events	Amp-Hours Saved	Energy Saved (kWh)	Cost Savings ($)
July 16–21*	5	524	3772	438
Aug. 8–12	4	185	1335	155
Aug. 13–19	2	27	195	22
Aug. 20–26	1	60	431	50
Aug. 27–Sep. 2	3	150	1080	126
Total	15	946	6813	790

Observing a ~1MW peak load reduction, 7% of load for participating buildings

Johnson Controls

Case Study: Empire State Building

RESULTS

- 38% energy savings, guaranteed
- Simple payback under 3 years
- Anticipate LEED Gold certification
- Energy Star Top 10% of U.S. office buildings
- 33% reduction in cooling load
- Savings of $4.4 million annually

Johnson Controls