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Managing Energy Using Key Performance Indicators

Siemens Retail & Commercial Systems

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Overview

Peter F. Drucker once said "What's measured improves." Key Performance Indicators (KPIs), while at times overused as a cliché, are in fact a means to an end. KPIs are metrics; they afford management visibility to the fulfillment of the intended objectives of systems or processes. KPIs should drive business value.

With this white paper, Siemens RCS addresses two types of KPIs for energy managers to consider. The first grouping is comprised of high-level or industry-level KPIs. They are intended to serve as guideposts for dialogue as your company considers the strategic role that energy efficiency and sustainability will play in the management of your business. The second type is more specific to the Siemens RCS Energy Management System (EMS), SiteControls. These are variables that have over time proven critical to program success.

Regardless of the specific metrics you chose to implement, Siemens submits two key points for your consideration. First, for KPIs to be successful, they must be highly visible. Management at all levels should have access to readily view both the definitions for the KPIs as well as the most recent results for each. Moreover, access may differ by stakeholder. Above-site visibility for management, actionable regional level views for department heads, and drill down capabilities for field technicians are great examples. Ideally, KPI trending information should be made available so that seasonal factors or other variables may be considered as well.

Second, incentive structures should be aligned with the adopted KPIs. Bonuses, performance reviews and other objective-based criteria should include quantifiable and time-based improvements to the baseline KPIs. As sustainability and energy efficiency strategies often affect multiple functional disciplines within an organization, so too should the metrics themselves and the employees that impact them.

In this paper we explore in greater detail the nine strategic and the seven Site Controls-specific KPIs. See the appendix for summaries.

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Strategic KPIs

Energy Cost Index (ECI)
Often viewed as overly simplistic, the ECI simply measures the total energy costs (such as electricity, steam, gas, water) of a company. It is expressed typically in dollars, as a percentage of total revenues, or as a delta to periods prior, typically annually. Certainly, it is comprised of demand and supply variables, each of which entails unique impact levers.

Site Energy Use Intensity
Focused on the demand side of energy, this metric dimensionalizes consumption by air conditioned square footage. It is typically expressed in British Thermal Units (Btus) or converted into kilowatt hours (kWh), per square foot, per year or month; or in percent reductions thereof. This is the most common metric for measuring energy efficiency programs that reduce consumption.

Source Energy Use (SEU)
This is also a demand metric. However, it not only captures the consumption specific to a site, but it also quantifies the energy transmission, delivery and production losses. See the graphic below from the US Environmental Protection Agency.

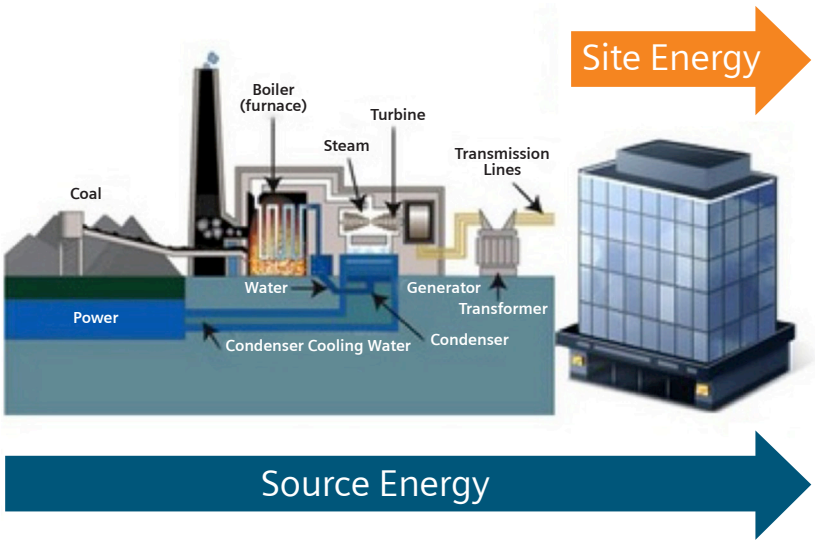
This is considered a more holistic metric as it accounts for the efficiency of an energy unit and its proximity to the destination of its ultimate use. The SEU KPI is less common, but increasingly important as companies derive a higher percentage of their total energy use from locally-generated renewable energy. It is a highly valued KPI, particularly for companies that utilize varied energy inputs. It is also expressed in Btus per air conditioned square footage per year or month.

Productivity Index
Quite common, productivity indexes the rate at which energy is consumed per unit of input. These KPIs should be catered to the drivers specific to a business. Examples include Btus per person or kWh per pound.

System Performance
These KPIs measure the energy efficiency of mechanical systems per output unit. They are a snapshot in time and may vary distinctly at times of day or year, or even season. Common examples include kWh/ton cooling or kWh/gallons pumped.

Load Factor
This KPI measures power, synonymously referenced as demand (kW). A sensitive metric, load factor quantifies behavioral changes at a location, both good and bad. Expressed as a numeral, this KPI is average demand (kW) divided by peak demand (kW). Here, a lower number is considered desirable.

Average Minimum Demand
Also expressed in kW, this KPI seeks to identify the minimum power requirements of a site at its lowest point of utilization. For some buildings this may be at 2am, or for others at 11pm. Regardless of the time of day, it serves as a leading indicator of opportunities to gain control over the specific load profile of that location and to over time reduce energy consumption.



Source Energy Use (SEU)
SEU not only captures the consumption specific to a site, but also quantifies the energy transmission, delivery and production losses.

Sustainability Index
Sustainability indexes are common, thorough and often industry specific. Often expressed as a ranking, each index provider utilizes multiple and often differing variables. Categories may include: environmental policy, staffing and auditing, ethical investments, renewable energy & waste recycling, among others. Consider the options, in concert with the strategic objectives of your company. The graphic above is an example of the People and Planet Green League which focuses on the education space. Others, such as the Carbon Disclosure project, have wide participation: Siemens ranked 98 last year!

Greenhouse Gas Emissions (GhG)
This variable is key for companies heavily focused on a strategic sustainability plan. Despite widely considered comprised of four gases (carbon dioxide, methane, nitrous oxide and flourinated gases), GhG emissions are typically expressed as the equivalency of metric tons of CO2 or a percent reduction thereof.

Type of Sustainability Plan						
Elements Addressed	**Energy & Utilities Plan**	**Energy Strategic Plan**	**Climate Action Plan**	**Facilities Master Plan**	**Sustainability Plan**	**Sustainability Master Plan**
Energy	☌	☌	☌	☌	☌	☌
Air/Climate	☌	☌	☌	☌	☌	☌
Education and Outreach					☌	☌
Facilities	☌	☌	☌	☌	☌	☌
Land and Space						☌
Transportation			☌	☌*	☌	☌
Public Health						☌
Procurement				☌*	☌	☌
Waste				☌*	☌	☌
Water				☌*	☌	☌

*Related to buildings only

Site Controls-specific KPIs

Energy Outliers
Siemens employs the concept of working the worst 5-10 percent of sites, HVACs, or devices first under the belief that doing so generates the greatest positive impact to the organization. It also greatly assists with the prioritization of issues that, in an often reactive world, provide a more effective deployment of limited resources (capital budget, employee availability and other resources).

Siemens defines energy outliers as an aggregate of three individual metrics: consumption or site energy use intensity (kWh/sf/mo); load factor (average/peak demand); and average minimum demand (kW). A Site that triggers a high consumption metric may have a very different root problem than one that exhibits particularly high average minimum demand. However, a site that exhibits high Outlier scores most assuredly costs the company money unnecessarily and should be dispatched for optimization.

HVAC Health
Siemens ranks each HVAC unit with regard to performance on a scale of 0-100, with 0 being undesirable or failed and 100 exhibiting no issues. Health is a great proxy for the efficiency (and thus cost effectiveness) of an HVAC unit and ultimately translates to expected lifespan of that unit. Siemens recommends weekly review of this KPI.

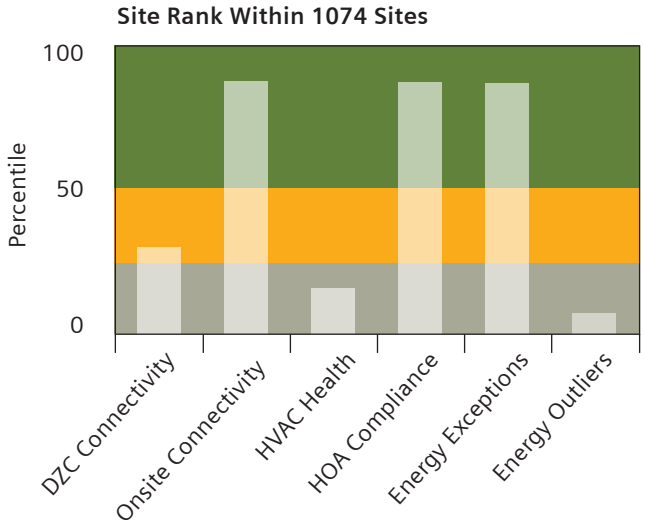
Setpoint Non-compliance
Corporate setpoint standards drive considerable savings. Deviating from those norms, due say to multiple, failed HVACs, does increase energy consumption and as such needs to be monitored. Deviations need to be reportedand setpoints reverted back to the corporate standard where possible. To ensure maximized savings, Siemens recommends a monthly review.

Site Controls KPIs (continued)

Lighting Exceptions
Hand-Off-Auto (HOA) switches afford onsite technicians the ability to locally defeat the lighting controls during times of troubleshooting, repair or remodeling. When not in the Auto position, the EMS is not controlling the lights and they are ON 24x7, often resulting in excessive energy consumption. Hence, Siemens recommends daily review.

A SiteControls component that controls the lighting control outputs, the Input/Output (I/O) board utilizes normally closed contactors. This is important in that when the I/O board loses power, all lights stay ON 24x7 to allow the site to continue to operate normally. The downside is that it results in excessive consumption if left to operate in this manner for longer than necessary. Siemens recommends review 2-3 times per week. The graphic below shows the Site Controls Data Center dashboard referencing the Energy Exceptions, including the I/O metric.

The EMS Breaker metric monitors the breaker that powers the I/O board. If it is flipped or tripped, it will, like the HOAs or the I/O board, have the same impact: lights are ON 24x7. Siemens recommends review 2-3 times per week. This metric is also included in the Energy Exceptions graphic below.



Digital Zone Controller (DZC) Connectivity
DZCs control individual HVAC units. When connectivity is lost to the HVAC, visibility to the zone and supply temperature sensors is lost, along with the ability to exercise control beyond the default settings in the DZC. Since the DZCs derive their power from the HVAC, lost connectivity is more than 80% of the time attributable to the HVAC having lost power. Siemens recommends a review once per week.

Site Connectivity
This measures the number and percentage of EMS-controlled sites that have connectivity to the cloud-based portal. The most important of KPIs, connectivity determines the ability of a company to actively control, or change controls, to a specific site. Said differently, it is of little use for you to have a nice Xerox printer in your office to which you cannot print. Siemens recommends review daily.

Overrides
Local personnel at times have a need to deviate from the master schedule or setpoints due to comfort issues or potential unscheduled cleanings. Push buttons onsite provide for a temporary adjustment to these standards. However, excessive usage of these tools may occur, hence the need for monitoring.

Sites with excessive overrides may have valid schedule needs not accurately reflected in the EMS and which require change. Alternatively, a site may be abusing this feature. Siemens recommends review once monthly.

Summary

In closing, KPIs vary widely – and in most cases they should. Consider this paper as a framework; a basis for strategic thinking, tactical planning and directional execution for your company.

In the words of Vince Lombardi, "The only place success comes before work is in the dictionary." Siemens can help you prioritize the work in front of you, so you can achieve success.

Appendix

Strategic			
Key Indicators	**Purpose**	**Unit of Measure**	**Polarity**
Energy Cost Index	Measures total annual energy costs (electricity, gas & water)	Dollars; figure reported may be absolute costs and % change over prior period	Lower value is better as it signals fewer energy outputs or greater efficiencies
Site Energy Use Intensity	Measures total site energy consumption (electricity, gas & water)	Energy units {British thermal units (Btu) or kilowatt hours (kWh)} per air conditioned square feet over time (generally expressed over a year or month)	Lower value is better as it signals fewer energy outputs or greater efficiencies
Source Energy Use	Measures the total site energy consumption plus it incorporates all energy transmission, delivery, and production losses	Energy units {British thermal units (Btu) or kilowatt hours (kWh)} per air conditioned square feet over time (generally expressed over a year or month)	Lower value is better as it signals fewer energy outputs or greater efficiencies
Productivity Indices	Measures the rate at which energy is consumed per unit of input	Energy units; Examples – Btu/person, kWh/lb, gallons water/lb	Higher value is desired
System Performance	Measures the efficiency of mechanical systems at a single point in time per unit of output	Energy units; energy input per desired output generated; common metrics: Examples – kW/ton cooling, kWh/gallons pumped, Cubic Feet – Minute/Horsepower air	Higher value is desired
Load Factor	Measures site behavioral changes in demand	Power (kW); average demand/peak demand	Lower value represents less fluctuation in demand profile
Average Minimum Demand	Measures the average demand daily representing the lowest point of demand for any facility	Power (kW); generally best identified during least productive part of day (e.g. 2 am)	Lower value demonstrates lower demand, which equates to less energy consumption over time
Sustainability Index	Ranks the entitiy with regard to others across a multitude of variables	Multiple; Examples – Dow Jones Sustainability Index, Carbon Disclosure Project, People and Planet Green League	Multiple; generally higher value is desired
Emission Generated	Measures emission of greenhouse gases (GHGs)	Equivalency of CO2 metric tons; Carbon Dioxide, Methane, Nitrous Oxide,Fluorinated gases	Lower value is better

Siemens Site Controls			
Energy Outliers	Monitors relative degree to which site consumes energy	Number; kWh/sf/mo + Min overnight lows (kW) + Load factor {avg/peak demand (kW)}	Lower value is better
HVAC Health	Measures efficiency of HVAC performance	Percentage of effective HVAC performance	Higher value is desired
Setpoint Non-compliance	Reports HVACs that have setpoints that deviate from corporate standards	Percentage of HVAC units	Lower value is better
Lighting Exceptions	Measures Hand-Off-Auto switches that are in AUTO (compliant) position; reports Input/Output boards not communicating; reports flipped or tripped breakers powering I/O components; thus leaving lights controlled ON 24x7	Percentage of compliant HOAs, Number of breakers & I/O boards	Higher value is desired for HOAs; lower values for I/Os & and EMS1 Breakers are better
Digital Zone Controller (DZC) Connectivity	Measures the connectivity rate for DZCs; thus indicating how many HVACs actively under control	Percentage of DZCs communicating and controlled	Higher value is desired
Site Connectivity	Measures controlled sites where connectivity is maintained	Percentage of site connected	Higher value is desired
Overrides	Reports by sites the hours of setpoint or schedule overrides that deviate from corporate standards	Hours of overrides	Lower value is better

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