Energy master plan reduces costs

Need higher efficiency? Drop the piecemeal approach to managing energy and sustainability initiatives. An integrated energy master plan, including discrete, batch, and processing lines, helps industrial and manufacturing companies realize cost, efficiency, and operational benefits.

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Energy management and sustainability decisions were less complicated for most facility managers not long ago, with decisions like switching to fluorescent lighting, installing a more efficient HVAC system, or upgrading to more integrated process controls architecture to streamline production. These and other initiatives may have been undertaken to make a company more energy efficient, productive, and sustainable. Today, managing such a task can become a significant challenge with industrial and manufacturing companies spread over large campuses or multiple facilities, often with varied production systems and geographic locations. Facilities that have high energy usage, deal with hazardous materials, or have sizable waste disposal issues face additional complexities.

For large operations, campus facilities, or companies with multiple locations an energy audit alone may be insufficient to cover all mitigating factors. A clearly written roadmap helps define and achieve energy and sustainability objectives.

Comprehensive energy planning

A fully integrated energy master plan resolves the integration of energy and sustainability projects and assets in large industrial, manufacturing, and institutional facilities. Such a long-term, broad-scoped plan puts in place a company's strategy to optimize all facets of energy efficiency and sustainability. This begins at the purchase of energy and other utilities and covers all aspects of their use, distribution, measurement, and minimization of waste. The plan establishes recommendations on how to best use energy assets and how and when to add and replace them efficiently.

Energy master plans also provide detailed steps to plan for energy and sustainable systems within each building or multiple locations. The buildings, and the energy and sustainable initiatives installed within them, are integrated into a uniform and holistic system.

Energy master planning phases

1. Investigation
- Interviews
- Identify constraints
- Data gathering
- Sustainability and energy audits

2. Visioning
- Review findings
- Consider technology trends
- Clarify vision
- Confirm plan forward

3. Analysis
- Design opportunities
- Utility opportunities
- Financial merit
- Timing to implement
- Draft master plan—multiple approaches

4. Deliverables
- Final master plan—single approach
- Schedule and phasing
- Communication tools
- Supporting documentation

Source: Control Engineering and SSOE

A comprehensive energy master plan details how to use energy assets, how and when to replace them, and how to efficiently add them.

Energy master plan components are not entirely new, though the necessity of putting them into an integrated package is a new approach, as many larger companies seek to make smarter energy decisions. This approach allows energy managers to recognize opportunities for conservation, sustainable design, and renewable energy that more narrowly focused energy audits might not.

'An energy master plan that integrates facility and process functions creates value for an industrial, manufacturing, or institutional facility.'

Integrated automation

An integrated energy master plan, because of its comprehensive protocol, will address facility operations and process functions. For example, integration in a cement plant of discrete control automation systems and process functions into a centralized controls architecture can significantly reduce process cycle times and production per labor hour, as well as improve throughput, energy usage, and equipment return on investment (ROI). An integrated energy master plan would address this.

A food processor that is blanching and chilling pasta in 10,000-lb batches per hour will find that a continuous cooking and chilling method can process the same volume of pasta in the same time, while reducing costs for heating the cooking water. An integrated energy master plan would discover the benefit of the continuous processing method over batch processing and see the energy conservation in using the spent, warmed-up chiller water as make-up water for the cooker. Less energy is used to sustain a 200°F cooking temperature than cycle through the batch process.

An energy master plan that integrates facility and process functions creates value for an industrial, manufacturing, or institutional facility.

Incorporate business goals

Further, such a plan considers higher-level, long-term business goals of a company. It may be an image the corporation desires to portray, such as reflecting environmental awareness, energy conservation, or possibly healthy working conditions for employees by promoting a working environment with sustainable materials. In this regard, an energy master plan extends beyond those responsible for energy management, into the upper strata of corporate decision making for marketing, human resources, facility operations, and investor relations.

Through a systematic analysis of these interdependencies and optimized energy benefits, a much more efficient and cost-effective energy plan can be realized that accounts for long-term business goals of a company.

Sustainable initiatives

With frequent energy cost increases, power quality issues, and stiffer pollution regulations, the need for streamlining energy usage and providing for sustainability issues continues to grow. Facility managers are being hit with a barrage of energy-efficiency and sustainability information from suppliers. Mandates from local, state, and U.S. government agencies require decisions from company managers on issues that many have little previous experience handling. Additionally, the influx of incentives promoting energy-efficiency, as well as renewable and alternative energy production, can bring benefits.

Companies may not have considered energy asset portfolio details and what the optimal next incremental investment would be to enhance sustainability. Is this the year that an industrial company should be converting its fleet to natural gas? Or do the market trends show that two years from now such a switch would be half the cost or offer better tax credits, and therefore it should wait?

Laws, regulations, and reporting requirements from the U.S. Environmental Protection Agency and local building codes continue to increase. Many companies are unaware of these regulations, and many would not know where to begin if required to implement them.

Energy savings for industrial operations, manufacturing

Through a newly forged agreement to reduce its energy intensity by 25% over a 10 year period, Opto 22 has become a Save Energy Now Leader and part of a United States Department of Energy (DOE) nationwide initiative to reduce energy consumption and energy intensity within the industrial operations and manufacturing sector.
As a Save Energy Now Leader, Opto 22 will work with representatives from the U.S. DOE's Office of Energy Efficiency and Renewable Energy's (EERE) Industrial Technologies Program to establish the company's energy use and energy intensity baselines, develop an energy curtailment plan, report its progress in reaching its reduction goal, and share energy usage data annually with the DOE.
DOE defines energy intensity as the energy consumed for each unit output from an industrial process. With the manufacturing sector consuming almost one-third of the nation's energy, tracking and gradually decreasing energy intensity (while continuing to maintain and grow production) is perhaps the single most effective strategy for businesses to reduce operating costs, increase competitiveness, and limit risk due to fluctuating fuel prices, while also reducing carbon emissions and overall reliance on fossil fuels.
By joining the Save Energy Now program, Opto 22 continues conservation, recycling, and sustainability efforts that began in 2006 when the company implemented more energy-efficient HVAC systems, maximized use of natural sunlight, and otherwise combined technology with common-sense practices to successfully reduce its carbon footprint and overall power consumption by 29%.

www.eere.energy.gov/industry/saveenergynow.
www.opto22.com

Conflicting goals

A manufacturer may have a budget of three million dollars a year dedicated to improving energy assets. It may have six plants in as many states with varying power consumption and power quality issues, variations in air quality, and differences in wastewater effluent and treatment processes, and a dozen other influencing factors. Where are the optimal locations for capital investments?

It has been common practice for manufacturing, industrial, and institutional facilities to contract with third-party suppliers to implement energy and sustainability projects. The piecemeal approach of individual projects lacks full integration and foresight and can result in non-optimized energy usage and a failure to fully realize broader objectives.

For example, a pharmaceutical processor, to become more sustainable, may desire to install a combined heat and power (CHP) capability to offset electric and hot water costs by capturing biogas from its wastewater treatment plant. But 10 years earlier, the plant upgraded its wastewater treatment to an aerobic reactor, incapable of producing sufficient biogas for CHP. Had an integrated energy master plan been put in place earlier, the pharmaceutical processor would have foreseen the CHP opportunity within its plant and built an anaerobic reactor instead, which produces usable biogas.

Energy plan integration: 4 stages

An integrated energy master plan is individualized for each company, but includes the following four-stage parameters:

1. Investigation – The first phase of an integrated and comprehensive energy master plan is investigation. What is a company trying to achieve? What is, and what is not to be considered within the scope of the plan?

This involves interviewing key personnel relative to known and unknown problems regarding energy, production, and maintenance issues. It also includes identifying constraints, such as financial, physical, cultural, zoning, and any other limitations that may be intervening factors in an energy strategy.

The investigation also includes a review of historical utility bills; a review of the company's carbon footprint and emissions; and the gathering of relevant facility, electrical, and mechanical drawings, specification sheets, and automated energy management system records.

2. Visioning – This phase gathers key decision makers, such as the chief executive officer, head of energy, or the head of facilities, to understand and unify the vision and goals. Are the goals to reduce energy consumption over a period of time, to manage risks, to add renewable energy, or some combination? How do these goals tie in to the overall business objectives of the company, including such influencing factors as product line changes and expansions, and facility build-outs or acquisitions? What does the company want to end up with 10 years from now, so that can be backed into a 10-year or 5-year plan?

Visioning presents an in-depth review of the findings from the investigation phase, including quantifying and visualizing system consumption and output; benchmarking to baseline and best practice systems; summarizing objectives and critical issues; identifying opportunities to pursue; and considering potential paths to follow.

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This step also reviews energy and sustainability technology trends.

Moreover, it clarifies and modifies the vision for the energy plan, as needed to achieve its stated goals, and to determine what is to be included and excluded, as well as to determine how to manage constraints.

3. Analysis – A company now looks at all opportunities available, compared with the clarified vision and plan. It more closely investigates those technologies that can be used and assembles basic costs and a phasing schedule to stagger the introduction of the technologies deemed most effective. A multiple-approach master plan is then drafted.

This part assesses energy and water efficiency, facility and equipment enhancements, heat and water recovery, control systems, sustainable systems, utility billing rate structure, peak shaving and shifting, and onsite power generation, including renewable energy.

4. Deliverables – The final phase encompasses finalizing the energy master plan. This comprehensive plan includes an investment plan, energy targets, building sustainability targets, emissions and car-

Proper cabling a critical choice for VFD systems

By Alpa Shah
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By integrating some logical steps into choosing the correct VFD cabling system, you can ensure many years of trouble-free service for your drives. The selection criteria for the proper cable system for VFD applications need to be understood in order to ensure a proper installation and operation.

The VFD cable should be able to withstand the operating conditions like repetitive 1,600 volt peak voltage spikes from low voltage IGBT drives and at the same time not deteriorate the performance of other drive system components. Peak voltages on a 460V system can reach 1200V to 1600 V, causing rapid breakdown of motor insulation, leading to motor failure. If this is left uncontrolled, insulation failure may occur.

The same peak voltages that damage the motor can also damage the cable. In the perfect cable power delivery system the net instantaneous current flowing in the total cable system should be zero. This includes all phase conductors, all ground conductors and shield. This can be achieved by a symmetrical cable.

Symmetrical cable

In a VFD installation the IGBT switches are in constant operation at high frequency and this produces an inverter output voltage with a PWM wave. This IGBT switching also causes a motor line to ground voltage, normally called a common mode voltage. Most AC drives, in addition to their normal three phase output voltages, create a fourth unintended voltage to ground, known as common mode voltage.

Common mode current is current that leaves a source and does not come back to the source. In most closed loop electrical circuits, most of the current returns to the source. However, there is a small amount of current that in any circuit is radiated and does not return.

The common mode voltages cause short high-frequency pulses of common mode current to flow in the safety earth circuits, and it is essential that the common mode currents return to the inverter without causing EMC-EMI problems in other equipment, and this means that the common mode currents must not flow in the safety earthing system.

The best and easiest way to do this is to use shielded VFD cables that are

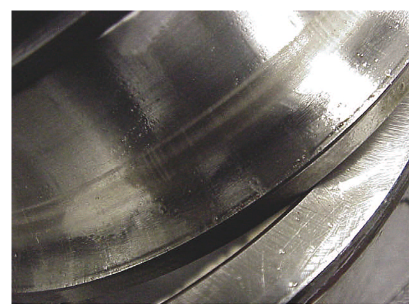

Figure 1: Pitting

properly terminated and provide a low impedance path for common mode current to return to the inverter.

If symmetrical insulated grounding conductors and an overall EMI shield are not used, EMC-EMI problems are very likely to occur creating a electrically imbalanced cable. An electrically "balanced" cable is produced when the effective distance from all phases to ground is identical. VFD cable where multiple grounds are placed in all interstices under tight manufacturing tolerances improves phase impedance. Additionally, ground sizes combined with the shield offer a higher than normal ground conductor size. This provides low ground-return impedance that helps to minimize common mode currents.

At the motor end, IGBT PWM drives can sometimes create insulation breakdown between the phase windings because of high transient bon footprint targets, operational targets, informational targets, and maintenance and upkeep targets. The plan also identifies final budget and resource commitments.

This section phases in the technologies and determines how the capital will be administered. It assembles the needed internal communications tools, such as implementing a cultural shift at the facility locations that talk about reducing water consumption or turning off lights. It includes everything needed to understand what this plan is, how to communicate the plan, how to present it to management, and then how to implement the plan.

Total energy management

There is superior value in consolidating all company energy assets into one package. For optimized feasibility, integrating facility and process systems with a company's overall sustainability objectives is ideal for a complete and integrated approach.

Energy master planning is a valuable fundamental building block for all high-energy-consuming industrial and manufacturing operations for reducing energy usage and utility costs, and promoting sustainability. Energy master planning provides efficient, long-term management of a company's energy assets.

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voltage peaking. End users notice reduced bearing life on motors soon after additions or upgrades to PWM drives. On inspection, minute pits similar to those seen in Figure 1 are discovered on inner and outer bearing races as well as on the motor bearings within a short period. Another observation that confirms the presence of a bearing current is a phenomenon known as fluting. Upon start-up of a motor an audible "groan" is usually heard coming from the motor that changes pitch and becomes quite noisy as the speed increases. Such a symptom usually points to bad motor bearings that have fluting damage as shown in Figure 2.

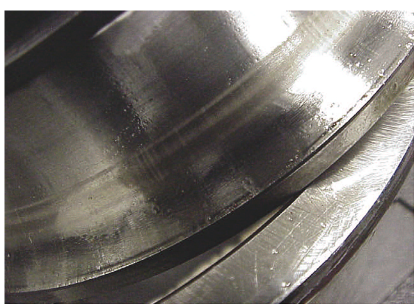

Figure 2: Fluting

The incidence of damage caused by bearing currents has increased during the past few years because of variable speed drives with fast rising voltage pulses, high switching frequencies that can cause current pulses through the bearings and due to repeated discharging gradually erodes the bearing races.

To avoid motor bearing damage, it is essential to provide a proper path for high frequency and allow stray currents to return to the inverter frame without passing through the bearings. The magnitude of the currents can be reduced by using symmetrical VFD cables with proper terminations.

Benefits of Proper Grounding and Cabling

Standard equipment grounding practices are designed to provide a sufficiently low impedance path to protect people and equipment against system faults. A VFD can be effectively earthed at the high common mode current frequencies by using symmetrical VFD cables. A symmetrical arrangement of three-phase leads and three-ground conductors minimizes the net injected ground current into the drive system and reduces problems arising from noisy ground current from VFD cables that augments the problems of system performance and electronic reliability.

Terminating the shield is just as important as having a continuous shield path. VFD installations would benefit from watertight cable connectors that can provide a 360° electrical bonding of the copper tape shield and the armor.

Users should connect the copper tape shield to the connector body in a manner that it provides a 360° connection. The connector assembly also should be designed to prevent loosening of threads caused by vibration.

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The Optisound VU3X Series Continuous Ultrasonic Level transmitter provides a reliable, repeatable and highly accurate (0.15%) continuous level measurement of liquids. It is capable of liquid level measurement to ranges up to 30 ft. (9.1 m), with a 2-wire 4-20mA, HART output signal. It is constructed of CPVC for use in environments that are classified hazardous (Class I, Div. 1) with Intrinsically Safe or Explosion Proof installation requirements, temperature range from -40°F to 158°F (-40°C to 70°C) and with process pressures up to 50 psig. The compact electronics comes standard with an integral display and keypad for local configuration and precludes the need for expensive hand-held communicators or PC software.

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