PDHonline Course E281U (3 PDH)

Practical Plant Energy Reduction – 2009 (Audio Version)

Instructor: Thomas Mason, P.E.

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PDH Online | PDH Center

5272 Meadow Estates Drive
Fairfax, VA 22030-6658
Phone: 703-988-0088
www.PDHonline.com

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Practical Plant Energy Reduction – 2009

Thomas Mason, P.E.

Course Content

Strategy

The scope of the current task is to reduce plant energy consumption five percent. That is, most simply, gather the current month's utility bills and make changes so that this month, next year, the billed usage is 5% less than the current billed usage.

Sidebar - Who established this scope?

Throughout this course, there will be boxed commentaries, similar to this. The boxes contain meaningful content, intended to answer implied questions in the core material.

Who said, "Reduce plant energy consumption five percent"? The State of California said 20%.

Well, 5% is a lot easier than 20%, and if you can demonstrate a 5% reduction you can get a lot more support for actions for further reductions.

I also think that we will discover that 5% reduction can be done by applying generic solutions, whereas a 20% reduction will require a careful study of the plant process and modifications to the processes. The time, manpower costs and support costs for critical evaluation of plant processes are not easily available. Also, process changes draw immediate criticism from all parties involved.

Is it really possible to achieve a 5% energy reduction in a well-run plant?

There have been several intimations already in this course to the political obstacles to energy reduction efforts. Specifically, those presently in charge may take it as career-threatening personal criticism to suggest operations could be performed more efficiently.

For reference, please share a review of auto mile-per-gallon results over the last 20 years.

In 1990, American cars were delivering 10-15 mpg. Japanese cars were delivering 12-20 mpg.

In 2009, American cars typically deliver 15-25 mpg. Japanese cars deliver 20-35 mpg.

In 2009, both Ford and GM are promising 35mpg fleet average by 2015.

Clearly engineering was applied to improve automobile net mileage efficiency, including engine changes, transmission changes, friction coefficients and the weight being hauled around. But, respected automotive engineers swore each year that no further mileage improvements were possible without sacrificing performance and safety. They were wrong.

Similarly today's plant managers, operations managers, process engineers and facilities engineers who claim that we are already in the "best of all possible worlds" are wrong. Throughput and quality can be maintained and improved while reducing energy usage.

Who is the class presenter to attack present plant managers and engineers?

First, it is an error to take the position that proposed energy reduction is an attack on present plant managers and engineers. Rather, energy reduction is an essential step to keep plants open and managers, engineers, operators and maintenance crews employed. Managers and engineers better take a leadership position and suck in the pride that claims reductions are impossible.

The presenter for this course is a registered professional engineer who has been performing plant energy studies for about 40 years. He has been intimate with the instrumentation and data and calculated savings. He has watched the recommendations be ignored in almost every instance. Most often, the rejection was based upon unsatisfactory payback - even at 12 months.

Today's task avoids the payback question. It doesn't matter. If we keep paying increased maintenance indefinitely to achieve 5% energy reduction, we have successfully completed the assignment. The maintenance problem is a maintenance problem and must be solved by maintenance professionals. Today's problem is energy reduction, and we have the solutions.

Regarding strategy, there are two key questions, as follows:

What CAN we do? and,

Which of the actions will yield greatest return?

Both questions require immediate action items, to get answers, as follows:

IMMEDIATE ACTION ITEMS (reproduced in checklist appendix)

1. Extract and trend monthly energy usage and energy costs for at least 12 months.
2. Identify results of 5% reduction of each and get stakeholder buy-in for up-front funding at 100% the indicated annual savings.
3. Start a plant energy balance. Use utility billing information.
4. Start a list of large energy using equipment, light fixture area served, count and wattage, motor tags and namplate hp, steam sources and uses and lb/hr nameplate, compressed air sources and uses and nameplate scfm, chilled water

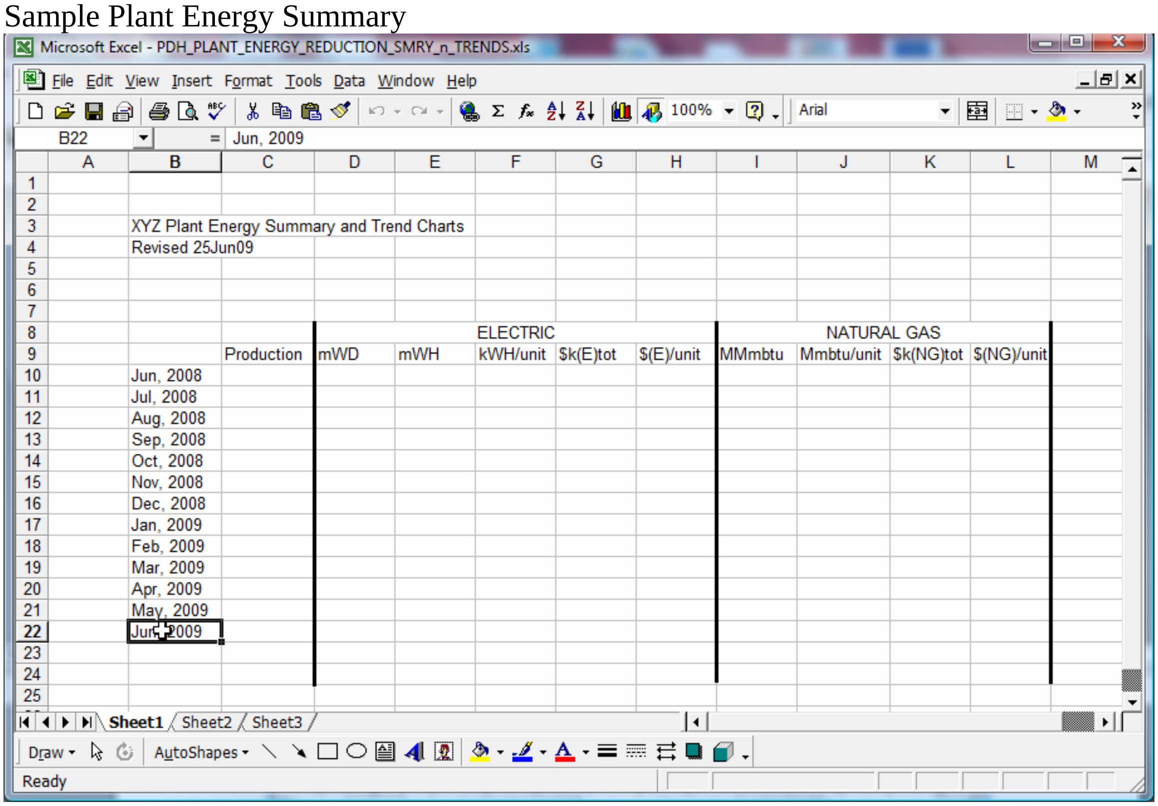
sources and uses and nameplate gpm. Continuous-duty machines and lights get first priority.

5. Start identifying and inspecting waste streams.

Monthly Energy Summary and Trend Charts

WARNING - Keep it simple.
Persons who have taken basic or advanced EXCEL courses want to show their skills. Please avoid the temptation. The Energy Summary and Trend Charts are to communicate two values only - usage and change in usage. We have suggested some extra columns to simplify comparison between months, but try to avoid the compulsion to calculate annual averages and overlay them on the annual trend summary. Averages hide data rather than exposing it. Do not do the analytical calculations within the Summary and do not plot variances as trends. The reader will want to do his own calculations in order to take ownership of the data and results. Variances are extremely qualitative, far beyond the difference between two month's totals. If variances are appropriate, they should be narrative, not simply numeric. This course recommends NOT calculating $/kWH. This reports a factor external to plant energy usage. It is an extremely valuable measure, but distracting to the content of this report.

Sample Plant Energy Summary



This course will not explain how to find the metered kilowatt demand (kWD) or metered kilowatts used from the electric bill. We will not explain your local natural gas bill either. If this becomes a serious impediment to moving forward on the project, call over to Accounts Payable in Accounting and arrange a visit with the person who handles the utility bills. Almost without exception, this person is very knowledgeable about the billing structure and will help you. He can also give you the name and phone number of someone in the utility who will talk to you.

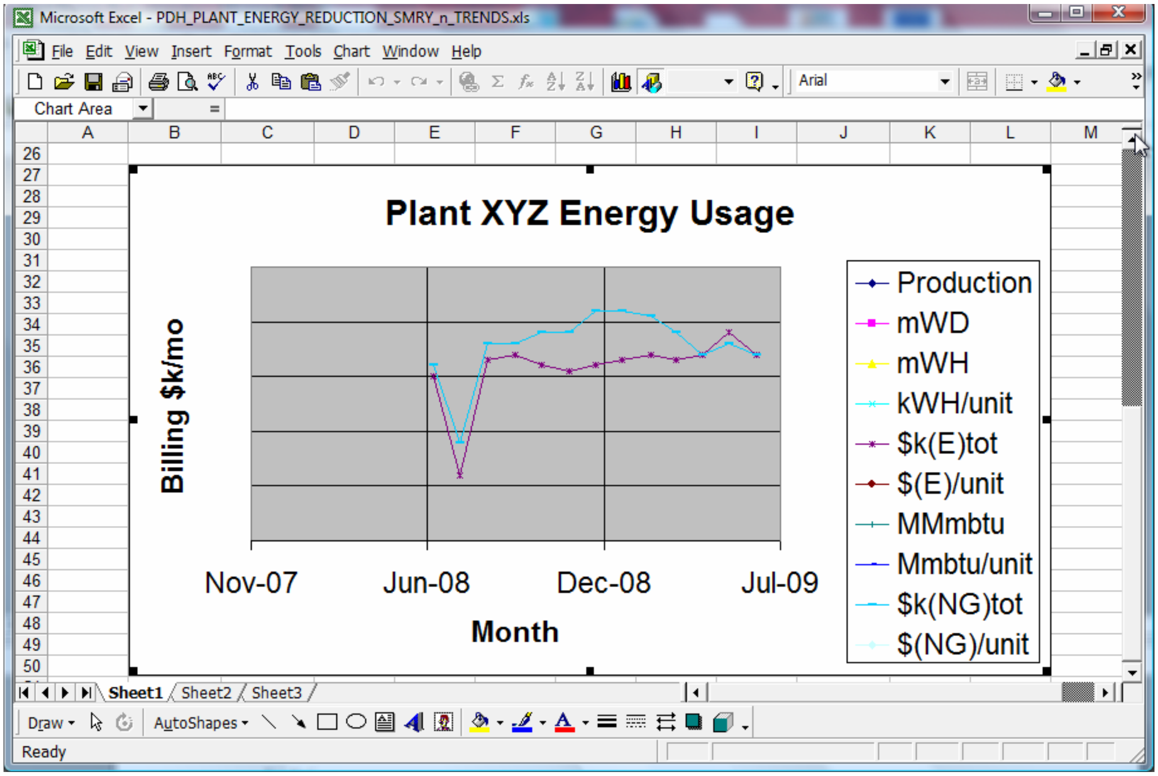
This is the point at which you find out if the mandate for energy reduction is real. If the funded goal is another study, you still need $100,000 for meter rental and installation, thermal imaging rental and use, number crunching and first-class reproduction of the report.

WARNING - Internal utility tracking is critical but not addressed as a first-step action item.
A plant which has a large skid-mounted liquefied CO2 unit will want to track CO2 use. Similarly, if the steam plant takes up a major part of the overall plant footprint, you will want to track steam usage. Chilled water is essential to many plants and the chillers, pumps and piping deserve close attention. Net chilled water usage will be required on the fully-developed Utilities Summary. But, these are derived energy flows. The first step is to track incoming, clearly monitized energy flows.

The advantage of the recommended Energy Usage Summary is that it focuses your attention and that of your audience on numbers and our scope, with limited commentary. It is a necessary first step to answer the question, “What can we reduce?” Obviously things connected to the electric substation must be reduced to reduce electric usage. You can’t reduce electric usage by simply reducing the voltage. Things connected to the natural gas meter must be reduced to reduce natural gas usage. As we build the plant energy balance diagram, we will begin to identify and label these things.

Why not reduce the voltage to reduce electric usage?
Because, for high intensity discharge lighting (fluorescent, metal halide, mercury vapor) and motors, when you reduce the voltage, you increase the amps. Increasing the amps increases the line losses and produces greater energy usage.

Sample Plant Energy Trend Charts



The good news is that Microsoft Excel has a fairly good charting utility built in. If you store your collected data in Excel, it will help you make presentable charts.

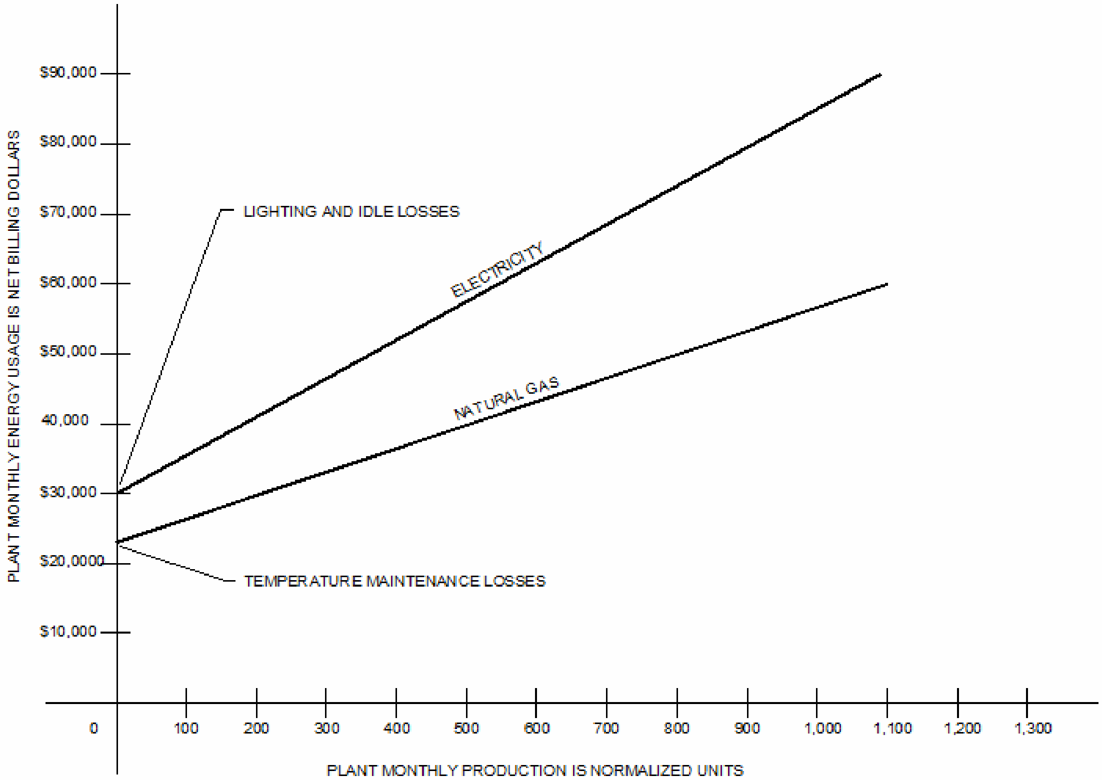
Do spend some time "playing around" with the charting options to find a look that communicates your message.

DO NOT let corporate Graphics Department help you. They will explain that information presented at the executive level must follow their standards. They will not explain to you that last-minute revisions are impossible and, often, you will not be permitted to see your finished product until it is projected to the executive audience.

On the other hand, it is valuable to cultivate available staff skills and improve your own skills. Working "with" corporate Graphics is desirable; just keep ownership of the data and presentation for yourself. Be warned though, that corporate Graphics may attempt to charge labor and materials to your project. This can be discovered by talking to the project accounting group which handles your project.

What value is contributed by the Trend Charts? The value is that they permit you to grossly observe the plant "response function" to external variables, as production rate, climate and totally unplanned events, such as a power outage. As we proceed, we will participate in planned plant outages and observe the plant "response function" in closer detail, and measure the energy losses of leaks when a department in off-line.

The most simple interpretation of the plant response function is linear algebra, with a y-intercept and a slope.



GENERIC LINEAR PLANT RESPONSE FUNCTION

The plant response function is totally conceptual. It represents the idea that there are fixed energy usages, regardless of production level. There are other energy usages, however, that vary directly with number of units produced.

An easy way to get a first approximation of fixed energy losses is to monitor energy usage during idle periods, as breaks for religious observances, shift change, shut-downs and the re-start cycle.

An implicit result of the columns kWH/unit and mbtu/unit is recognition that the plant experiences both good times and bad times. Using the good times as first order target helps us focusing on what is bad about the bad times. These are things we know about, that we can change. Obviously, to achieve the promised ultimate reductions, we will move on to targets even better than the good times of historic trends.

Project Budget

The sum of monthly electric charges for the year is the existing cost. A base implementation budget to achieve 5% reduction is 5% of the annual cost. 0.05 x annual electric cost is the amount you must spend on modifications for electric savings. 0.05 x annual natural gas cost is the amount you must spend on modifications for natural gas savings.

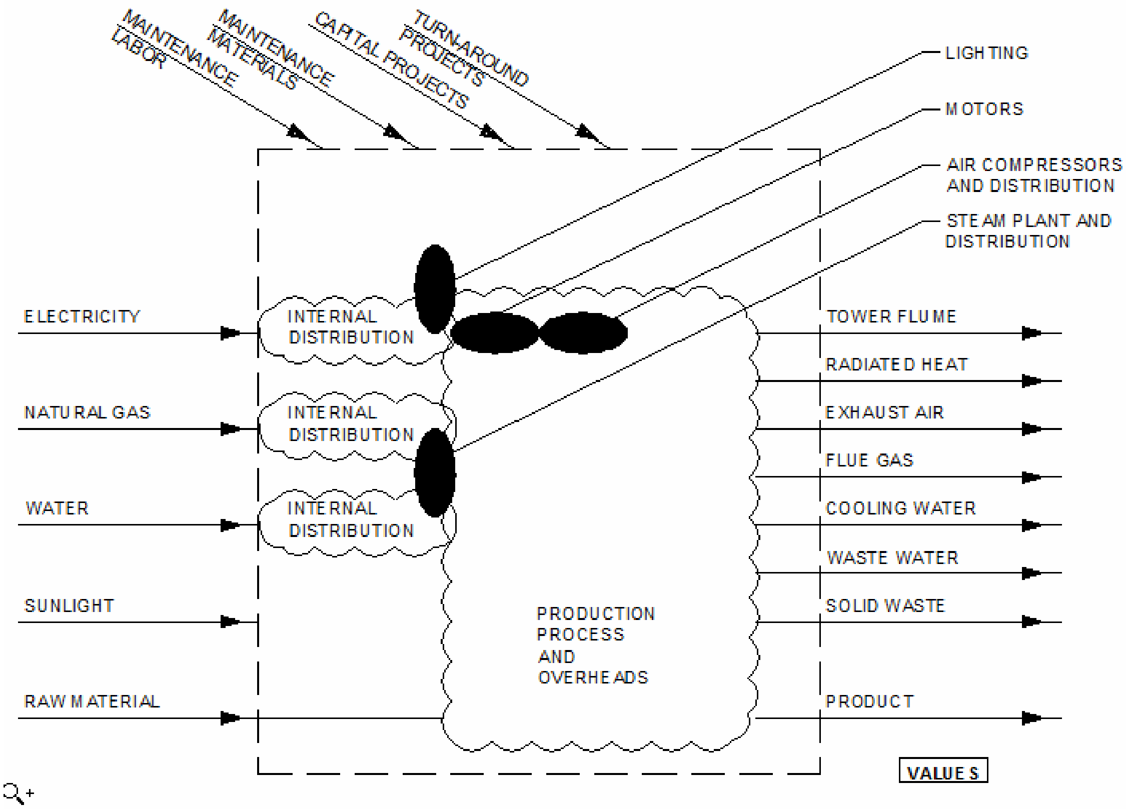
Hiding the cost - authorized subterfuge
Please see if you agree with the reasoning thus far. *You don't want to stick your hand into an energized piece of electric switchgear with a clamp-on meter*. If this statement is incorrect, then you have already hidden a substantial part of the study cost. If this statement is true, however, you have to find an employee or contractor to stick his hand into an energized piece of electrical switchgear with a clamp-on meter. Finding an employee is not recommended because the metering approaches illegal and assumes tremendous liability for the firm. Hiring a contractor, however, is legal and assumes slight liability, especially if you explicitly tell him to follow NETA (interNational Electrical Testing Association, *www.**neta**world.org/*), OSHA (Occupational Safety and Health Act, *www.**osha**.gov/*) guidelines and the meter manufacturer's instructions. Hiding the cost of the employee doing the testing is fairly easy. His supervisor can provide an overhead charge account that hasn't been used much and the work gets done. Hiding a contract with an electrical contractor or testing firm is more difficult. Best bet is to use an existing "blanket contract" (pre approved labor rate for small jobs for which the maintenance manager has signing authority). Again, the scope statement must include "follow NETA and OSHA guidelines and meter manufacturer's instructions." It is better NOT to be around when the testing is done. Writing a new contract for an unfunded project is extremely difficult. Best bet is to find a funded project that is delayed for unforeseen reasons and has a cooperative project manager. Again, you have executive support, just lacking funding. A phone call to the Project Manager from your executive champion may be all it takes.

Generic plant energy balance

The concept of the electronic spreadsheet is to start the summary report, then do the work to fill in the line items. Use this concept for your plant energy balance. Start with a generic diagram. Make the significant energy streams large and pursue values. Make the insignificant energy streams small and verify and record the tiny or zero values.

By the way, the term "energy balance" is used because this is a rigorous technique basic to chemical processes. The process engineer does the calculation which identifies how much energy is absorbed or released by the chemical reaction, then sizes his supply, discharge, heating and cooling piping to match. Here, we are not expecting to get the input MMbtu to exactly match the endothermic value plus the discharge. We must, however, be cognizant that the equation exists.

The generic plant energy balance diagram follows:



GENERIC PLANT ENERGY BALANCE DIAGRAM

where,

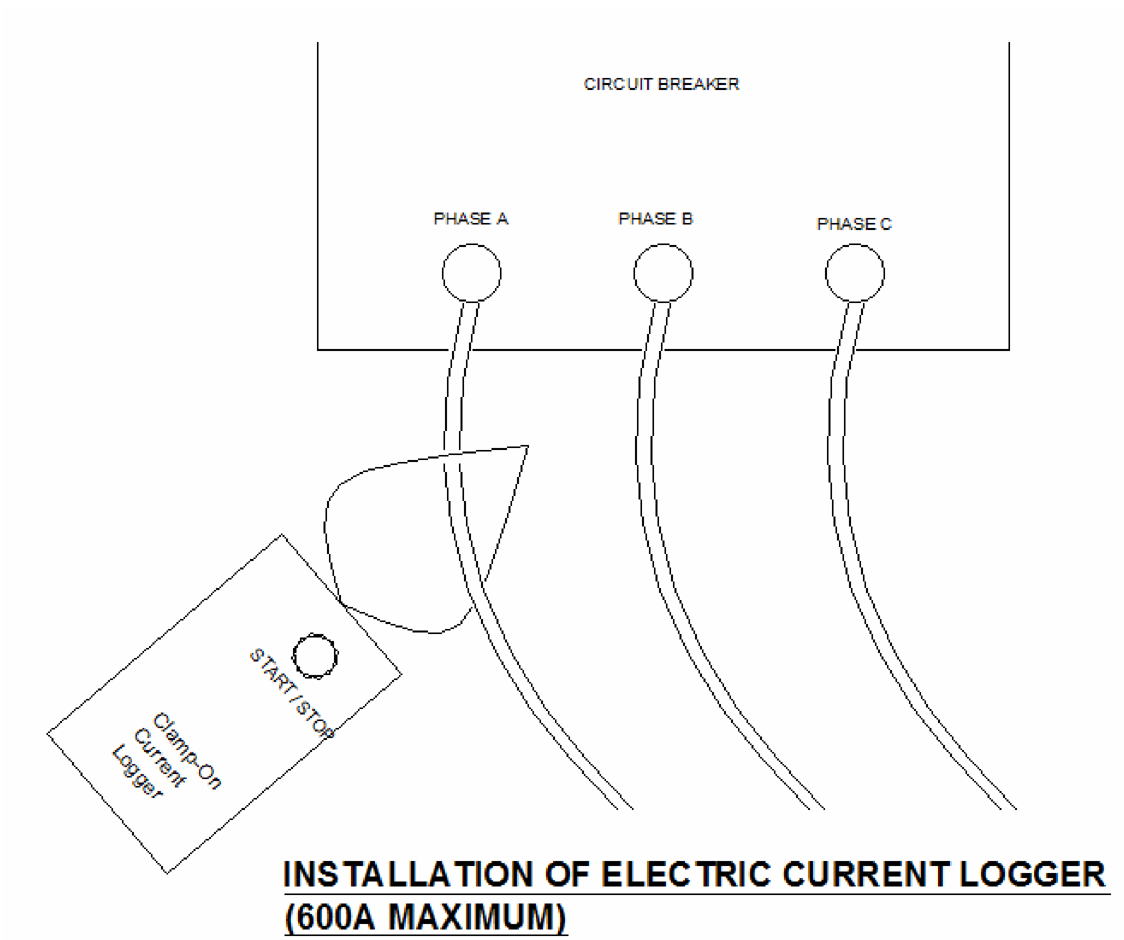
ELECTRICITY = sum of all electric utility service points. A drill-down supplemental screen shows each service point, utility metering, check metering, first level distribution and names the departments served.

Drill-down supplemental screen
The recommended form of the working copy of the project manual is a hypertext document, similar to internet webpages. At the top level, the plant energy balance is somewhat similar to the generic diagram just presented. Numeric values can be toggled on or off by mousing over the VALUES label and clicking. Monthly or annual amounts and costs can be turned on by the user of the document. The overall plant energy balance diagram is supplemented by individual pages (or screens) for each of the areas of interest. Necessarily there will be extensive information on electricity and natural gas. The electric supplemental page will have available lower-level pages giving individual substation and feeder trend data, shown with associated departmental production data.

Moving from the plant summary to the first level supplement to the lower level supplements is called “drilling down”. The feature is available in website design, Microsoft WORD and SCADA screen builders. A SCADA screen builder is recommended because the screens can “go live” at a later date and show real-time as well as archived data.

If hyper-linking and drill-down are foreign terms, you might want to talk to some new-hire engineers and look at Microsoft WORD help on HYPERLINK FIELD CODES. (You select a word on the source page and define a jump to a selected word on the destination page. Typically, the word on the destination is changed to hidden text to make the process seem magical.)

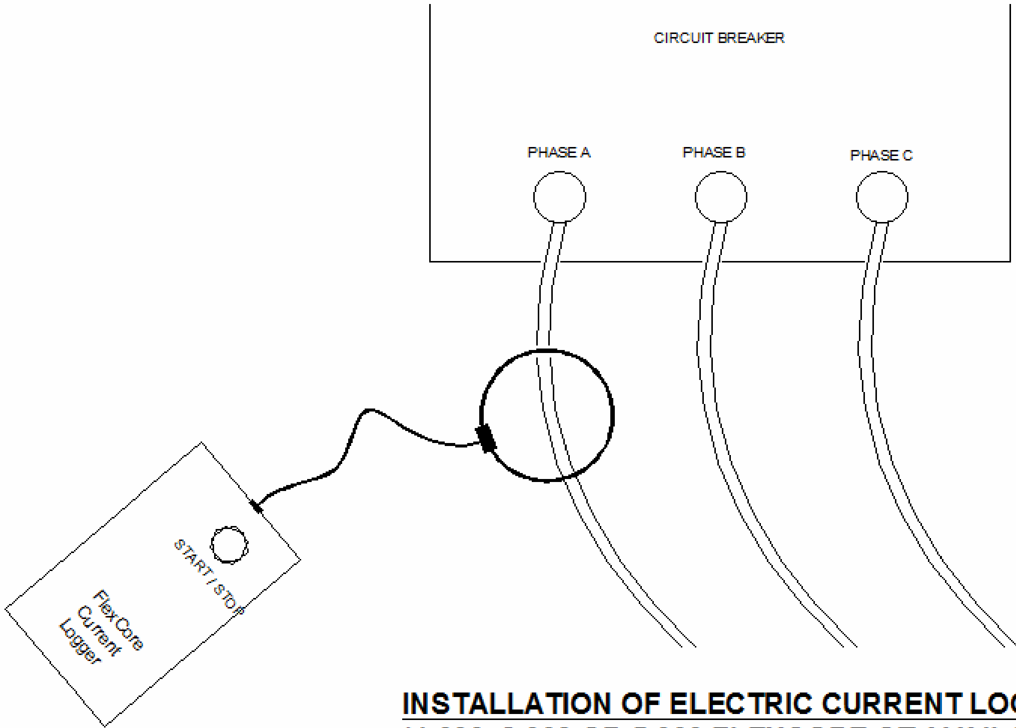
Installation of 600A (max) electrical survey meter.



Where, kWH = V(l-l) x I(l) x Srt(3) x .8 x hr .8 = approx power factor

FOLLOW NETA AND OSHA GUIDELINES AND METER MANUFACTURER’S INSTRUCTIONS FOR INSTALLATION

Installation of 1,000 – 5,000A electrical survey meter.



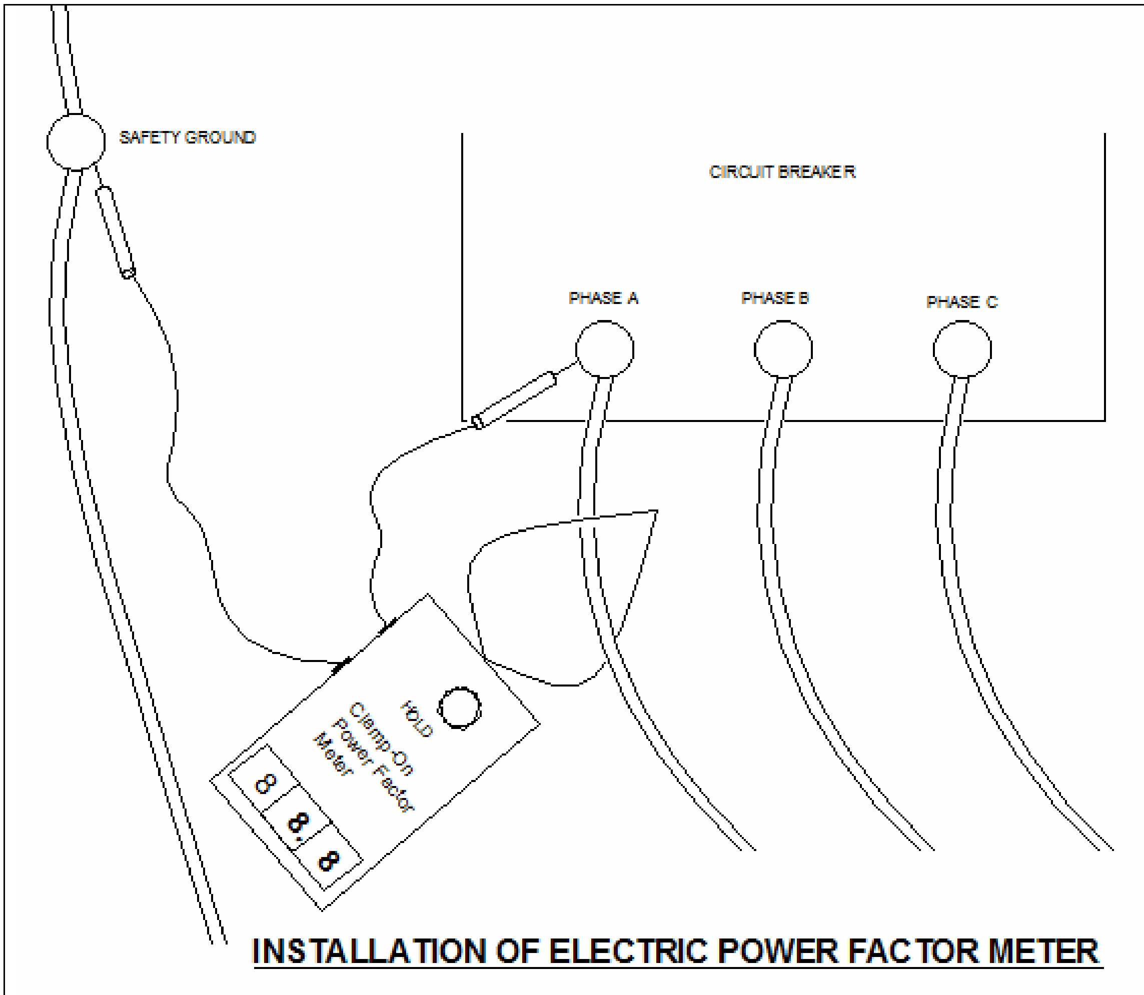
INSTALLATION OF ELECTRIC CURRENT LOGGER
(1,000, 2,000 OR 5,000 FLEXCORE CT AVAILABLE)

Where, kWH = V(l-l) x I(l) x Srt(3) x .8 x hr .8 = approx power factor

FOLLOW NETA AND OSHA GUIDELINES AND METER MANUFACTURER'S INSTRUCTIONS FOR INSTALLATION

(Flexible clamp-on is large enough to go around busbars.)

Installation of power factor meter.



FOLLOW NETA AND OSHA GUIDELINES AND METER MANUFACTURER'S INSTRUCTIONS FOR INSTALLATION (FlexCore adapters are available to increase the range of digital clamp-on meters.)

NATURAL GAS = sum of all natural gas utility service points. Natural gas is a little different than electricity, in that in-plant high-pressure distribution is more common and a single delivery point is practical. Nonetheless, it is common to have a plant made up of multiple buildings, each with a separate natural gas delivery and main meter. The drill-down supplemental screen identifies utility metering and main taps and departments served.

WATER = water usage is addressed as important, but put off until later stages of the project and not addressed by this course. The reason for inclusion in the diagram is that energy reduction is only a first step in environmental responsibility. Water usage reduction is expected to be a future mandate.

Zero-water-discharge plants are presently in service.
There are desirable manufacturing locations with very severe limitations on available

water. In response, major US manufacturers are operating plants with declared zero-water-discharge. (http://www.bluspr.us/
http://community.waterworld.com/forum/topics/zero-discharge
http://www.nmfrc.org/bluebook/sec27.htm

SUNLIGHT = sum of radiant heat gain from the sun which must be managed by HVAC equipment. By recognizing this energy stream in the top level summary, groundwork is laid for modified roof coloring and insulation. It is appropriately part of an energy balance as sunlight is a heat input which moves to the cooling water and waste heat discharges of the plant.

RAW MATERIAL = The energy state of the raw material used by the production process may be significant. In the steel industry, incoming and intermediate products are alternately heated and cooled in the forming and properties control stages. Trucks on the interstate highway carrying ingots may benefit the plant energy usage by insulation or enhanced cooling.

TOWER FLUME = Wet cooling towers suck in outside air and blow it through sprays of plant cooling water to bring the plant water down to a temperature approaching the outside air temperature. The discharge air is called "tower flume" and contains droplets of plant water and heavy concentration of minerals and treatment chemicals. The magnitude of the discharged heat is a measure of losses that can be eliminated to reduce energy usage.

RADIATED HEAT = Dry cooling towers are called by many names, including fin-fans. The term fin-fan describes the operation. Plant cooling water, or any process fluid, is pumped through a heat exchanger with fins, like a car radiator. Outside air is blown across the fins to take away the heat. The rejected heat is called radiated heat here.

EXHAUST AIR = The normal standard for in-plant ambient air is human comfort. In winter, heat may be added to keep it above 60F. In summer, high-cfm exhaust or mechanical cooling may be used to keep it below 80F. Fans, heating air and cooling air cost money and the condition of the exhaust air is an indicator of the losses involved. To follow the energy balance flows, we need to include exhaust air.

Plant exhaust air fans may be 20-100HP, in continuous duty. Any reduction or elimination shows up as substantial energy reduction.

DIRECT-FIRED COMFORT HEATERS provide an opportunity for energy savings. These are not construction site "salamanders" but components of sophisticated HVAC systems.

FLUE GAS = Flue gas is the common term for stack discharges from a fired steam plant. Extensive studies have been made to minimize the waste components of flue gas. Modern home furnaces are termed "98% efficient" because the flue gas is just slightly above 70F. Modern home furnaces condense acid from the flue gas that was formerly handled by the high temperatures and convection of the chimney. The same problems apply to flue gas recovery in the industrial setting.

COOLING WATER = Cooling water is the normal label for internal plant pipes carrying process water used for cooling purposes This is an important measure of waste heat rejected by the process which, of course, corresponds to heat input.

A second meaning for cooling water is heat rejected into a river or tributary. It has the added incentive for control because of increasing EPA regulation. A major opportunity of reduction of purchased energy is reuse of formerly rejected heat.

WASTE WATER = Waste water ranges in class. Boiler blowdown is especially concentrated, chemically treated water. The contained chemicals and dissolved solids are damaging to equipment and to the environment. Most cooling water, listed separately, is non-potable (non-drinkable), but not hazardous - appropriate for irrigation, with some restrictions. Chemical waste, mixed with plant water can be very toxic (see zero-discharge web references, above).

SOLID WASTE = Solid waste is the total of scrap created by the process, reject product and a wide range of ancillary materials not worth reclaiming.

Process rejects as a measure of energy waste.
The introduction to every course on quality control explains that labor is invested in work-in-process. If defects are found in a inspection stage late in the process, then labor to that point has been wasted. This concept applies to energy usage. Often, substantial energy is invested in the product stream early in processing. If defects are found that cause rejects, the energy that has been invested is wasted - produces no benefit. I worked tech service for a plant that used electric arcs to melt sand and cast ceramic blocks to make glass furnaces. (Glass melts at a lower temperature than ceramic.) The plant had a 60% reject rate and was satisfied with the profit margins until the EPA decided that reject ceramic blocks, totally inert, are toxic. Regarding plant energy reduction, there would have been substantial plant energy reduction by reducing the reject rate.

PRODUCT = Product is the sum of salable items produced by the plant. It is fairly easy to identify the product leaving the shipping dock, but very difficult to come up with a representative sum for use in the energy summary. It is essential to do this to identify energy usage variances associated with production and energy usage variances resulting from weather, maintenance failures, raw materials failures and work slowdowns.

Some firms have an accounting unit that invests full-time efforts in tracking the energy usage invested in each unit product. This is not our goal. On the other hand, we need a monthly production rate to use as a reference for energy usage.

Avoid gaming.
If the energy reduction efforts are taken seriously, there will be many interested persons looking at the monthly energy summary and the $(E)/unit. There is a compulsion for every person who has studied business since 1970 to argue the source of the numbers instead of working to improve plant operations. This is called "gaming" or "gaming the system". The numerator of $(E)/unit is hard to argue (but some will). The denominator, units produced, is easy to argue. However, this argument is a distraction. Any one of a number of moderately accurate (but consistently applied) measures of "units produced" will work for energy use analysis. Efforts to modify the "units" measure method should be accepted, along with a requirement that the person suggesting the change rework all archive calculations according to the new procedure, to maintain comparability.

MAINTENANCE LABOR = Maintenance labor is a placeholder value for the plant energy balance. We really don't care how much is spent, but we must recognize that any changes approved for energy reduction will have a corresponding installation cost which has to show up in maintenance and/or capital costs. It is very likely that there will be long-term maintenance costs associated with energy reduction changes.

MAINTENANCE MATERIALS = Maintenance materials, again, is a placeholder value for the plant energy balance. Each effort for energy reduction will, necessarily, have both a labor and a materials cost.

CAPITAL PROJECTS = Capital project are big-ticket items, usually resulting from long term planning and justification. Legitimately, big-ticket installations or renovations for energy reduction should be placed in this category - except for the long term planning and justification.

This item is placed on the plant energy balance to remind everyone of the cost involved in the current task, and, perhaps, to suggest that energy reduction efforts can be combined under the heading of an existing capital project.

TURNAROUND PROJECTS = Turnaround projects are a special type of project in continuous process industries. Oil refineries typically schedule a shutdown every three to five years and delay major work for those times. Everything in-between is band-aid style. The turnarounds are closely orchestrated for maximum benefit from minimum process interruption.

The paperboard industry has a similar concept they call washdown. At the beginning of a cycle, the machines are clean and they make the whitest board. As the machines get dirty, they make dirtier and dirtier board, ending with kraft, which is not supposed to be seen by end-users. After kraft, they shut down the mills and undertake washdown of the machines and maintenance which requires still shafts.

Turnaround projects are included on the plant energy balance as a possible funding source and to remind all that measurements across the shutdown process yield tremendous information on process energy usage. The goal of watching and metering utilities at shutdown is to try to identify the leaks and waste components NOT associated by product creation.

LIGHTING = Lighting, external, in-plant, security and quality control are listed separately because they are such a large electricity user. Placing numeric usage and cost values on the high-level summary and energy balance diagram help focus attention of the opportunities available in modifying lighting provided.

You must reduce wattage consumed by lighting.
The first required step is to analyze electric bills to see how much kWH reduction is required to achieve 5% savings. The second step is to get a count on lighting fixtures and wattages and hr/day to see how many kWH/mo are going to this use. The third step is to see how much fixture wattage can realistically be reduced. Expect to recommend 60-90% in every location except quality inspection and executive conference rooms. An extended discussion of lighting measures and needs in included below.

Example #1 of lighting reduction.
AS FOUND: High bay manufacturing area, 400W Metal halide fixtures at 30-ft c-c. 0.44 w/sq-ft AS LEFT: Same high bay manufacturing area, same fixtures resourced from 277 V to 120V, ballasts bypassed, 55W self-ballasted compact fluorescent lamps installed. 0.06 w/sq-ft

Example #2 of lighting reduction.
AS FOUND: Office floor, 4-tube 180W fluorescent over each 8x8-ft cubicle, 2.8 w/sq-ft continuous. AS LEFT: Same office floor. Overhead lighting removed. Each cubicle has a 32w fluorescent uplight on switch added and 32w task light on switch added. 1.0 w-sq-ft, intermittent.

Is radical lighting reduction acceptable?
Two facts must be accepted before we can start a discussion of lighting levels. A) The eye's response to light levels is logarithmic. That is, a scene illuminated at 10 footcandles appears half as bright as the same scene at 100 footcandles. B) All measurements of lighting levels are bogus. That is, the same lamp in the same fixture drops illumination from 100 fc to 5 fc over its life. This is normal deterioration of lamp output and dirt buildup. It is common knowledge that you can replace an existing 400w fixture with a new 175w fixture and INCREASE lighting levels. We have returned to the starting point on the lamp depreciation curve and a clean fixture. This is gaming the system. The real-world situation is that we buy 400w fixtures; we pay electricity for 400w; but, as time goes by, we get 200w, 100w and 50w of lighting. Depending on the as-found condition, you may replace 400w fixtures with 55w fixtures and get an IMPROVEMENT in measured footcandles.

MOTORS = Motors on pumps, presses, milling machines, compressors and fans are major energy users in all plants. Some studies quote 60% of the energy usage going to motors. Unfortunately, motors have been optimized for about 100 years. It is still possible to get a 5% efficiency improvement on small (100HP-) motors by buying extra-high-efficiency units. It is hard to get 2% improvement on large (100HP+) motors.

Look at energy savings from changing out motors to extra-high-efficiency.
The first step is to look at the kWH reduction needed for the plant. The second step is to get tag numbers of motors and HP ratings and hr/day to see how many kWH are going to this use. Note that continuous-duty 1HP motors will demonstrate more percentage energy savings by change out to extra-high-efficiency motors than larger (already efficient) motors. The third step is to ask the maintenance manager which brand motors consistently perform best in the plant and take the list to the local salesman for a quote on extra-high-efficiency motors and expected energy savings in kWH/yr.

Extra-High-Efficiency Motors.
A sample of extra-high-efficiency motor specifications is included below.

AC Motors |

Premium Efficiency

Click on a Catalog Number to see the product overview.
OR Click on a column heading to sort the results.
OR Select attributes to the left to narrow the results list.
OR Try our **Power Search**.

Total Records: 953 **Page** 33 **of 64** **<< PREV | NEXT >>**

CATALOG NUMBER	PHASE	HP / kW	RPM	VOLTAGE	ENCLOSURE	NEMA
EM3714T	3	10 / 7.46	1760	230/460	TEFC	215T
EM3774T	3	10 / 7.46	1760	230/460	TEFC	215T
EM3774T-8	3	10 / 7.46	1760	200	TEFC	215T
EM7170T-C	3	10 / 7.46	1760	230/460	XPFC	215T
EM3711T	3	10 / 7.46	3500	230/460	TEFC	215T
EM3771T	3	10 / 7.46	3500	230/460	TEFC	215T
EM3771T-8	3	10 / 7.46	3500	200	TEFC	213T
ECP83771T-4	3	10 / 7.46	3500	460	TEFC	215T
ECP3771T-4	3	10 / 7.46	3500	460	TEFC	215T
CECP83771T-4	3	10 / 7.46	3500	460	TEFC	215TC
CEM3771T	3	10 / 7.46	3500	230/460	TEFC	215TC
CEM3771T-5	3	10 / 7.46	3500	575	TEFC	215TC
VECP3771T-4	3	10 / 7.46	3500	460	TEFC	215TC
EJMM3312T	3	10 / 7.46	3500	230/460	OPSB	213JM
EM3312T	3	10 / 7.46	3500	230/460	OPSB	213T

Total Records: 953 **Page** 33 **of 64** **<< PREV | NEXT >>**

http://www.baldor.com/products/product.asp?1=1&page=303

with drill-down for the first motor, 10HP, 1760RPM, 230/460V, TEFC, T Frame

AC Motors | Premium Efficiency |

Specifications: EM3714T

Catalog Number:	EM3714T
Specification Number:	37H244T849
Horsepower:	10
Voltage:	230/460
Hertz:	60
Phase:	3
Full Load Amps:	25/12.5
Usable at 208 Volts:	N/A
RPM:	1770
Frame Size:	215T
Service Factor:	1.15
Rating:	40C AMB-CONT
Locked Rotor Code:	J
NEMA Design Code:	A
Insulation Class:	F
Full Load Efficiency:	92.4
Power Factor:	82
Enclosure:	TEFC
Baldor Type:	3752M
DE Bearing:	6307
ODE Bearing:	6206
Electrical Specification Number:	37WGT849
Mechanical Specification Number:	37H244

http://www.baldor.com/products/specs.asp?1=1&page=33

Note: Baldor recommends NEMA A high efficiency motors for pumps and compressors.

5-30% energy saving are available on motors by shutting them down.

There are two ways to get immediate savings by shutting down motors when they are not needed.

The first method is scheduling. This works when there is a bank of pumps, boilers, or compressors feeding a manifold to supply the entire plant. In years gone by all pumps were kept on-line and all loaded proportionately as plant demand increased. Same thing for boilers, compressors and chillers.

The modern approach is to have one or more base load units running at capacity and bring in additional units as plant demand increases. This may will almost certainly require modification to the controls.

Additionally, there may be severe conflict from operators and supervisors who want to keep boilers on low-fire to avoid wide temperature swings and assure rapid response. However, power operated valves can keep feedwater flowing through the boilers even though the burner, main feedwater pumps and fans are off.

The second method of shutting down motors is during idle periods. An unloaded motor, spinning at rated speed, with process mechanical losses but not process value will measure 5-30% of energy usage when contributing to the process. The start-up losses in a well maintained machine should be minimal and not contribute to early failure.

The first step is to get at least 7-days of electrical amps charts for machines you know to cycle between loaded and unloaded. [Course suggests AEMC CL601, one phase only]

The second step is to examine the trend charts and look for periods exceeding 10-minutes downtime.

The third step is to calculate the monthly savings available, assuming kWH = V(l-l) x I(l) x srt(3).

AIR COMPRESSORS = Plant air compressors in a modern plant can approach the energy usage of the boilers in a early 20th century plant. The energy source is clean, easy to maintain and a selected power and cleaning source for a wide range of process equipment.

The downside is that air, being clean, does not remind maintenance to repair leaks. In addition, most leaks make ultrasonic noise rather than sensible noise. The energy losses from leaks approach those from steam leaks.

COMPRESSED AIR DISTRIBUTION = Compressed air distribution is the piping, connections, regulators and hoses between the compressor and the machine.

Find and fix compressed air leaks.
The first step is to buy an ultrasonic detector and have a maintenance person trained by the salesman to use it. (It is extremely logical and not burdensome.) Plan on tracing every compressed air line in the plant.

Selecting an ultrasonic leak detector instrument.
It is essential to get earphones and a parabolic pickup accessory. Ultrasonic detection is

qualitative, not quantitative. The sound clearly indicates to a trained person if you are listening to a compressed air leak, a steam leak or background machine noise. The magnitude is greatly affected by direction and reflections and is not a good indicator.

The Amprobe ULD-300 is a totally satisfactory first try. It is worth paying a little more to buy from a local representative who will provide a walk-thru and hands-on training for your selected maintenance person. The features of a $5,000 or $10,000 instrument provide no value.

A can of fluorescent spray paint with a 10-ft operating stick is extremely useful.

STEAM PLANT = Steam plant may mean a line-up of natural gas or oil-fired package boilers or a very large building with three or more coal-fired boilers. In addition, large steam piping, small steam piping, steam traps and condensate return piping make up the distribution system.

Flue gas and blow-down waste water discharges have been mentioned previously, but are huge waste heat sources.

For over 100 years waste heat in blow-down waste water have been reclaimed, usually via heat exchangers to preheat boiler make up water. Though this system is already in place, the target operating point has shifted radically with the need for plant energy reduction.

The first step is to check the discharge temperature of the blow-down waste water stream. If it is above 100F you have an opportunity for additional (and massive) savings. As noted above, this is heavily treated, toxic and high dissolved-solids fluid, and requires care in handling.

Boiler makeup is still a valid target for the use of the waste heat. Boiler makeup is heated from city water temp (often 50F) to nearly 300F. Using low-level heat to take it from 50F to 100F and higher quality heat from 100 to 150F is good economy. Makeup is especially appropriate as the blowdown and make up take place simultaneously.

For sixty years, at least, waste heat in flue gas has been recovered profitably. A limitation of taking heat from the flue gas has been condensation of acid when the dew point is reached. Today, we can (and must) accept this waste stream for EPA reasons along with energy reduction reasons.

Capturing additional waste heat from the flue gas stream is a major utility process change. Use part of your study funds to contract with an engineering firm specializing in this area (Washington Group of URS might be considered). It may be possible to get a "back of envelope" savings (and cost) estunate with the promise of an upcoming design job.

This may be a case where the importance of the plant modifications justifies a sole-source contract without competitive bidding.

STEAM DISTRIBUTION = Steam distribution is the piping and connections between the boiler and the machine or heater. Smaller heater have external steam traps which automatically open to let condensed steam (water) return to the feedwater system.

Find and fix steam leaks.
The first step is to buy an ultrasonic detector and have a maintenance person trained by the salesman to use it. (It is extremely logical and not burdensome.) Plan on tracing every steam line in the plant. If steam maintenance is done by a different crew than compressed air maintenance, buy two detectors, one for each.

Repair insulation and add insulation on steam lines, traps and condensate return lines.
The first step is to buy an thermal detector and have a maintenance person learn how to use it by trial and error. A $50 "gun" with laser pointer will get you started. Have a quick scan of steam lines, traps and condensate lines done to get a sense of the surface temperatures and how much unused piping is hanging there. The second step is to meet with the maintenance manager and agree on a plan to repair and upgrade the insulation. If insulation was removed (and not replaced) to do maintenance on a valve, it doesn't make sense to repair it with 2-in insulation, then come back and put another 2-in layer on top or rip off the new 2-in to install 4-in. The smart plan is to install 4-in at removable locations, such as valves and traps and give the maintenance crew a chance to determine if valve or trap maintenance is appropriate. Schedule coming back to add 2-in or ripping off the old 2-in and installing 4-in. This overview course cannot identify the correct type or thickness of insulation for your plant. The goal is to get the surface temp on all lines down to less than 10F above ambient.

What about thermal imaging?
Thermal imaging is digital photos of equipment with false color to indicate ambient, high and very-high temperatures. It used to be done with fancy gadgets and Polaroid film. It is now done with fancy gadgets and low-resolution .jpg files for computer viewing or color printing. The nicest gadgets permit both "normal view" and "thermal view". They are wonderful toys and essential for published studies. In addition to the $10,000 cost, you get a one-week training session. They provide no value beyond that of a thermal gun with laser targeting.

CHILLED WATER DISTRIBUTION = Chilled water distribution is the piping and valving that connect the chillers to the equipment. Such piping is insulated. As with steam piping, though, the target today for acceptable heat waste is less than when the original insulation was installed.

Repair insulation and add insulation on chilled water lines and valving.
The first step is to buy an thermal detector and have a maintenance person learn how to use it by trial and error. A $50 "gun" with laser pointer will get you started. If steam piping and chilled water piping are maintained by different crews, get two guns, one for each. Have a quick scan of chilled water lines and valving done to get a sense of the surface temperatures and how much unused piping is hanging there. The second step is to meet with the maintenance manager and agree on a plan to repair and upgrade the insulation. If insulation was removed (and not replaced) to do maintenance on a valve, it doesn't make sense to repair it with 2-in insulation, then come back and put another 2-in layer on top or rip off the new 2-in to install 4-in. The smart plan is to install 4-in at removable locations, such as valves and give the maintenance crew a chance to determine if valve maintenance is appropriate. Schedule coming back to add 2-in or ripping off the old 2-in and installing 4-in. This overview course cannot identify the correct type or thickness of insulation for your plant. The goal is to get the surface temp on all lines down to less than 10F below ambient.

(Natural gas and liquids)INTERNAL DISTRIBUTION = There are pipes and piping that carry electrical wires and natural gas and various liquids around the plant. Limited energy savings are available from maintenance and upgrade.

ELECTRIC POWER DISTRIBUTION = Electric power distribution is the cabling, transformers, motor starters and circuit breakers which get electricity to the equipment.

Power factor energy savings.
People who like to sell power factor capacitors claim savings by reducing magnetizing currents on the plant distribution system. This works up to 95% p.f. Above 95%, there is a danger of creating a leading power factor which is dangerous. (The discussion is beyond the scope of this course.) It is valuable to do spot checks of power factor, using a clamp-on meter, such as AEMC F09. Anyplace power factor measures below 90% during normal production, record the amps and check the sizing chart for a standard capacitor to bring it above 90% but below 95%. If the value is over 5kVAR, talk to a salesman (like Square D) about automatic switched capacitors. (Automatic switched capacitors will not go above 95% and are not especially dangerous.) It is desirable to place power factor capacitors as close as possible to the load, as at a large motor starter or motor control center. Capacitors do not coexist well with variable

frequency drives.

The installation of power factor capacitors reduces magnetizing currents to motors, thus reducing the total currents, line losses from the incremental currents and transformer losses from the incremental currents.

The motor capacitor table.

Suggested Capacitor Ratings (kVAR)
TABLE 1 – Indoor Low Voltage T-Frame NEMA Class B Induction Motors

Motor Rating (HP)	Nominal Motor Speed											
	3600 RPM		1800 RPM		1200 RPM		900 RPM		720 RPM		600 RPM	
	Capacitor Rating	% AR	Capacitor Rating	% AR	Capacitor Rating	% AR	Capacitor Rating	% AR	Capacitor Rating	% AR	Capacitor Rating	% AR
3	1.5	14	1.5	23	2.5	28	3	38	3	40	4	40
5	2	14	2.5	22	3	26	4	31	4	40	5	40
7.5	2.5	14	3	20	4	21	5	28	5	38	6	45
10	4	14	4	18	5	21	6	27	7.5	36	8	38
15	5	12	5	18	6	20	7.5	24	8	32	10	34
20	6	12	6	17	7.5	19	9	23	10	29	12	30
25	7.5	12	7.5	17	8	19	10	23	12	25	18	30
30	8	11	8	16	10	19	14	22	15	24	22.5	30
40	1	12	13	15	16	19	18	21	22.5	24	25	30
50	15	12	18	15	20	19	22.5	21	24	24	30	30
60	18	12	21	14	22.5	17	26	20	30	22	35	28
75	20	12	23	14	25	15	28	17	33	14	40	19
100	22.5	11	30	14	30	12	35	16	40	15	45	17
125	25	10	36	12	35	12	42	14	45	15	50	17
150	30	10	42	12	40	12	52.5	14	52.5	14	60	17
200	35	10	50	11	50	10	65	13	68	13	90	17
250	40	11	60	10	62.5	10	82	13	87.5	13	100	17
300	45	11	68	10	75	12	100	14	100	13	120	17
350	50	12	75	8	90	12	120	13	120	13	135	15
400	75	10	80	8	100	12	130	13	140	13	150	15
450	80	8	90	8	120	10	140	12	160	14	160	15
500	100	8	120	9	150	12	160	12	180	13	180	15

Please note: These tables are to be used for T-Frame NEMA class B induction motors only – please contact the Schneider Electric Power Quality Correction Group for any other applications, or motor types

ecatalog.squared.com/techlib/displaydocument.cfm.?id=5810HO9701&action=view

The demand savings fallacy.

The electric bill reports a metered demand in kW. There is an associated monthly cost penalty for high demand. It appears reasonable to reduce the demand (highest single draw of electricity during the month) and reduce the demand penalty and overall energy cost.

In fact, successful demand reduction saves more in energy, kWH, than in demand, kW. This is because the core concept of demand reduction is the identification of discretionary loads - which can be turned off without process penalty. Once these are identified, turn them off. The day or time is not important, if they do not contribute to process value, they are waste.

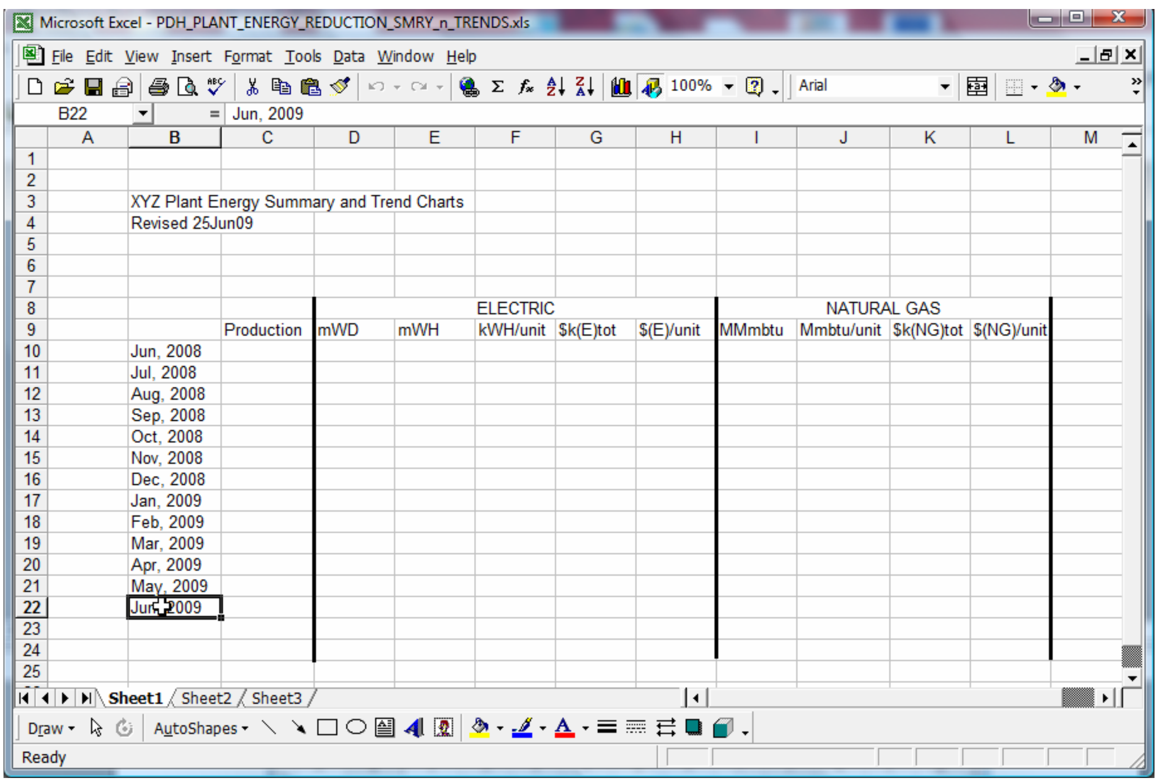
PRODUCTION PROCESS AND OVERHEADS = Production process and overheads are included on the energy balance because they are major portions of the plant operation. Anyplace where energy waste exists in process (as heat treatment or idling equipment for long periods) and overheads (such as packaging, materials transfer and office space), it must be addressed and plans made for reduction and elimination.

Checklists (in order or course presentation

1. Establish project scope, as 5% electrical and natural gas reduction on a comparative-month basis. Get commitment for $100,000 study funding and 5% energy usage capital investment.

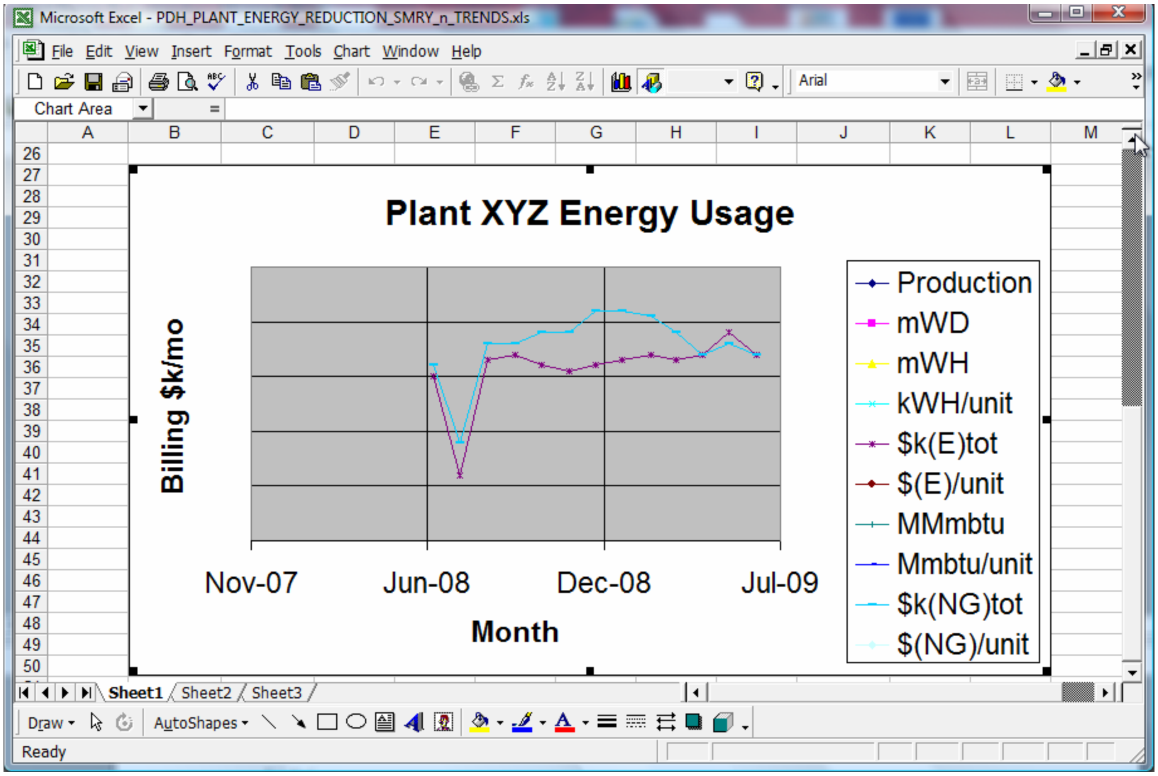
2. Have a kick-off meeting with your executive champion, plant operations manager and plant maintenance manager. Issue minutes identifying buy-ins.

3. Analyze electric bills and gas bills for min 12-mo; prepare a plant energy summary and trend charts.

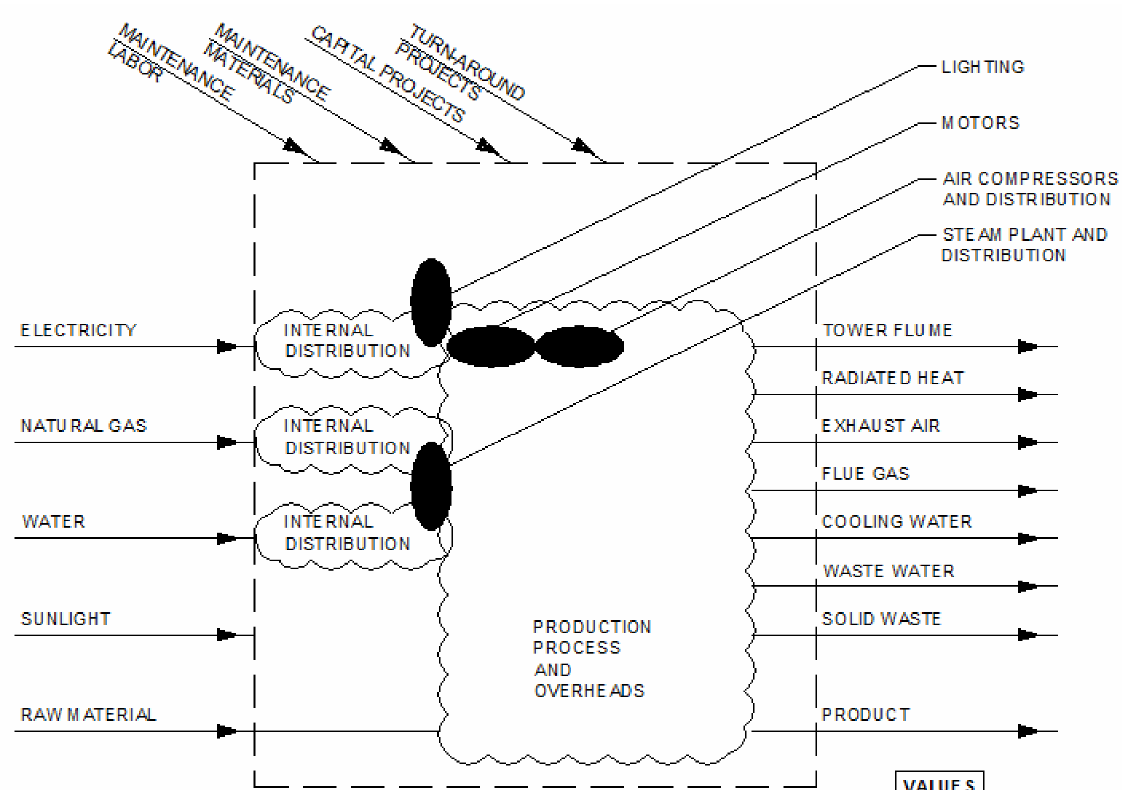

Microsoft Excel - PDH_PLANT_ENERGY_REDUCTION_SMRY_n_TRENDS.xls

XYZ Plant Energy Summary and Trend Charts
Revised 25Jun09

				ELECTRIC				NATURAL GAS		
	Production	mWD	mWH	kWH/unit	$k(E)tot	$(E)/unit	MMmbtu	Mmbtu/unit	$k(NG)tot	$(NG)/unit
Jun, 2008										
Jul, 2008										
Aug, 2008										
Sep, 2008										
Oct, 2008										
Nov, 2008										
Dec, 2008										
Jan, 2009										
Feb, 2009										
Mar, 2009										
Apr, 2009										
May, 2009										
Jun, 2009										



4. Start a plant energy balance diagram.



GENERIC PLANT ENERGY BALANCE DIAGRAM

5. Start a list of large energy using equipment, light fixture count and wattage, motor tags and nameplate hp, steam sources and uses and lb/hr nameplant, compressed air sources and uses and scfm, chilled water sources and uses and nampleate gpm.

6. Start identifying and inspecting waste streams.
7. Prepare first Work Order for specific fixture rework or replacement to reduce lighting energy 60-90%.

8. Use data logging ammeter to record power usage and power factor on major equipment and motor control centers.

9. Prepare first Work Order for replacing specific motors with extra-high-efficiency units.

10. Prepare first Work Order for installing fixed power factor capacitors on select motors and switched power factor capacitors on select motor control centers.

11. Prepare a Work Order for ultrasonic survey of compressed air piping, using fluorescent paint on stick applicator.

12. Prepare Work Order for repair of compressed air leaks.

13. Initiate discussions with engineering firm specializing in steam utilities regarding energy capture from flue gas and blowdown water streams.

14. Prepare a Work Order for an ultrasonic survey of steam piping and traps, using a different color fluorescent paint on a stick applicator.

15. Prepare first Work Order for repair of stream leaks and traps blowing-by.

16. Prepare a Work Order for a thermal survey of steam lines, traps and condensate return lines.

17. Prepare first Work Order for repair of removable insulation.

18. Prepare first Work Order for additional insulation on top of old or ripping off old and applying new.

19. Prepare a Work Order for a thermal survey of chilled water lines and valving.

20. Prepare a Work Order for repair of removable insulation.

21. Prepare first Work order for additional insulation on top of old or ripping off old and applying new.

22. Continue tracking monthly electric and natural gas bills. Celebrate and publicize savings. Use unfavorable variation as an incentive to expedite Work Orders.

[eof]