# Checklist for Energy Audit

This checklist is the result of a compilation of material from two sources:

- "The BESS Energy Management Checklist", which was derived from the Basic Energy Management Check compiled by Lloyd's Register Management Consultants on behalf of Senter Novem (the Netherlands); and
- "Energy Savings Toolbox – An Energy Audit Manual and Tool". This manual was developed under the auspices of the Canadian Industry Program for Energy Conservation (CIPEC), a joint initiative of Canadian industry and the Office of Energy Efficiency of Natural Resources Canada.

The compilation has been carried out with the aim of adapting the content to suit the TEST project.

The purpose of this checklist is to assist practitioners in systematically reviewing energy use in a company to identify focus areas that could benefit most from "energy efficiency" programmes. It provides a clear picture of which modifications and adjustments the company could make in order to achieve optimal and energy efficient operation.

The checklist is useful on several levels – energy managers and staff with the authority to set and adjust critical operating parameters can use this checklist and apply it in situations such as:

- Identification of energy conservation potential and improvement options
- Initiation of project and planning
- Needs analysis
- Project planning and procurement
- Commissioning and handing-over procedures
- Energy saving operation

**Energy aspect**

An energy aspect is anything that results in the consumption of energy. An energy aspect can be related to the delivery of a service, the choice and quality of an energy source and carrier, technology (e.g. equipment and start-up), organization (such as work processes and maintenance) and behaviour (e.g. compliance with job instructions).

**A practical auditing methodology**

The energy audit is a systematic assessment of current energy needs and energy-use practices in a process. Just as a financial audit examines expenditures of money, the energy audit identifies how energy is handled and consumed, i.e.:

- What are the energy needs
- How and where energy enters the facility, department, system or piece of equipment
- Where it goes and how it is used
- Any variation between inputs and uses
- How the energy can be used more effectively or efficiently

# TEST tools: Energy Audit Checklist

| Check out the following | What should you specifically do?/Key questions |
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| **Energy management** | |
| **Basic information** | Are the figures on energy consumption and its driving factors known and available?<br><br>*You are expected to have access to a summary (energy consumption analysis) of the processes, buildings and utilities with energy consumption data, for example per product line or per sub-process.* |
| | Has the organization identified the primary energy aspects based on the energy consumption figures (see definition below), and are they kept up to date?<br><br>Survey energy use and identify and quantify the significant energy users.<br><br>*The energy aspects that determine consumption in the processes should be mapped. These include both primary and secondary consumption, such as compressed air equipment (primary energy consumption) and the use of compressed air, which also affects consumption (secondary energy consumption). This overview needs to be kept up to date when process changes occur, for example.*<br><br>Have the energy consumption and consumption patterns been examined, including idle consumption during nights and weekends and consumption patterns? |
| **Structure and responsibilities** | Have tasks, responsibilities and authority been determined for all staff involved in energy management (e.g. energy aspects, energy consumption, objectives, corrective measures, etc.)?<br><br>*Here you should have a list of employees with tasks, responsibilities and authority in the area of energy that includes employees, coordinator, and department and/or management heads, in so far as applicable.* |
| | Are sufficient financial resources made available for managing and improving the energy aspects (consumption and efficiency)?<br><br>*This pertains to the financial resources for energy reduction measures, for example, or training employees in order to improve awareness/know-how, or for measurement systems (sub-meters, software for data processing), etc.* |
| **Management of activities** | Has there been agreement about the manner in which the energy consumed by the operating activities will be managed?<br><br>*The working method for managing energy consumption must be defined for the major operational activities (energy aspects). For example: instructions for operating equipment, manuals with start values, automated process control, maintenance system for relevant equipment and the responsibilities and authorization of employees.* |
| | Is there an energy policy in place? Is the energy policy known and adhered to by all relevant employees?<br><br>*Employees are expected to understand the organization's energy policy and to apply it when performing day-to-day activities.* |
| | Is information monitored and used to manage and improve the energy consumed by processes? |

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| | *Measurement data should be processed, used and discussed in managing the energy consumption of processes and in reducing energy consumption.*<br><br>*The monitoring referred to above includes:*<br>• *Energy consumption of department or process*<br>• *Energy efficiency projects (remodelling, major maintenance, etc.)*<br>• *(Graphic) trend analyses* |
| | When purchasing goods and services, are the consequences on energy consumption taken into consideration? (if relevant, are suppliers, contractors and third parties given instructions pertaining to energy consumption?)<br><br>*In purchasing, the energy consumption of goods and services and requirements in this area should be taken into consideration. When processes and equipment are modified, a reduction can be achieved if energy consumption is taken into account in the design.* |
| | Are the primary energy consumers (energy aspects) regularly measured, registered, analysed and reported?<br><br>*Measurement data for all the major energy aspects (largest users) must be available in sufficient detail. Sub-measurements are not always necessary, but are usually recommended, as is a comparison of the data with key figures for the sector (benchmarking). Analysis provides insight into energy performance, enabling the identification of improvement options, the progress being made, and possible non-conformance.* |
| **Training and awareness** | Is there sufficient necessary knowledge and information regarding efficient energy consumption, and have the employees who can influence the energy efficiency been instructed and/or trained?<br><br>*The individuals and groups in the organization must be trained or instructed in energy efficiency. The necessary level of know-how varies, depending on the part played by employees, from highly specific to general.* |
| **Communication** | Are energy performance and energy management regularly discussed internally on the operational and management levels?<br><br>*Energy (consumption, efficiency, non-conformance, progress in achieving objectives) is expected to be regularly included on the agenda for internal consultation with the relevant employees.* |
| **Objectives and targets and energy management programme** | Has a plan of approach been compiled for improving energy performance in accordance with the policy?<br><br>*A document must be available. The plan of approach must in general be specific, measurable, achievable, realistic, and time-bound (SMART).* |
| | In determining and evaluating the objectives, has the following been considered:<br><br>• Legal and other requirements<br>  ○ *Any permit requirements, construction regulations and requirements, e.g. on the parent company, must be taken into account.*<br><br>• The primary energy aspects<br>  ○ *Energy objectives and tasks should primarily focus on the (large) consumers where the most improvement can be expected to be achieved.* |

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| | • The best available techniques<br>  ○ *An organization is expected to be aware of the best techniques available and to use these if possible. The organization can keep up to date, for example, by actively participating in sector consultation with reference to energy.*<br><br>• Improvement of the indirect energy effects as caused by choice of materials, for example, or transporters and/or suppliers<br>  ○ *There must be insight into energy consumption and conservation possibilities in the value chain in which the company participates, and relevant objectives and tasks should be formulated.*<br><br>• The time schedule according to which these are to be achieved<br>  ○ *The points in time when implementation of objectives and tasks start and should be concluded must be clear. General requirements for the objectives are that they are SMART.* |
| **Evaluation** | Does management perform an evaluation of the energy management system at least once a year?<br><br>*The entire package of energy management measures should be discussed at least once each year in order to determine whether agreements are being met and the desired results (policy) achieved.*<br><br>In preparing for the evaluation, at least the following information must collected:<br><br>• Newly defined energy aspects<br>  ○ *When equipment, processes, buildings, etc. are changed, the company should check the list of major energy consumers and update it where necessary.*<br><br>• Energy performance based on monitoring information<br>  ○ *The energy efficiency should be analysed as a trend.*<br><br>• Comparison of performance indicators with benchmarks available for similar companies/processes/production units (if relevant)<br>  ○ *The energy consumption figures are expected to be compared to similar processes/companies in order to properly evaluate performance.*<br><br>• The evaluation of conformance with legal and other requirements pertaining to energy<br>  ○ *The company is expected to determine whether agreements and regulations have been satisfied in accordance with the policy.*<br><br>• An assessment of the effectiveness of the system for achieving the policy and the objectives is assessed<br>  ○ *The company is expected to determine whether the whole of the energy management measures ("the system") results in better management of the processes and a reduction in energy consumption.* |
| **Building envelope** | |

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| This section deals only with energy flows and losses from a conditioned space. Production (boiler, A/C) and distribution (HVAC) losses are covered elsewhere in this checklist. In addition to the energy flows from the heating or cooling source to the building envelope, it is important to recognise and understand the interactions between systems and how changing one system can affect another. For example, a reduction in the energy used by the lighting system could result in an increase in the winter space-heating requirements but a decrease in summer cooling. | |
| **Determine the need** | Document load on the heating/cooling system; separate fuel energy used for space heating from that used for cooling.<br>Determine design and actual end-use requirements: temperature, fresh air, etc.<br><br>*The load on the system will change as a result of other energy management actions at the point of end-use – this step may need to be revised periodically.* |
| **Meet the need** | Ensure space temperature is not significantly greater than the highest requirement. Operate at the minimum possible temperature (heating), maximum possible temperature (cooling).<br>Reduce flows/temperatures to match end-use requirements.<br>Reduce temperature stratification in high-ceiling areas.<br>Ensure cooling and heating systems are not “competing.” |
| **Maximise efficiency** | Minimise air leaks at windows, doors and vents.<br>Ensure windows and doors are closed during heating and cooling.<br>Ensure building insulation is up to standard.<br>Consider high-performance windows to reduce summer heat gains and winter heat losses. |
| **Optimise supply** | Maximise solar gains when heating and minimise when cooling.<br>Make innovative use of passive or active solar heating technology for space and/or water heating, especially when combined with improved insulation, window design and heat recovery from vented air.<br>Consider a solar wall – a metal collector designed to provide preheated ventilation (make-up air) for buildings with large south-facing walls. |
| **Lighting** | |
| | Identify the different bulbs/lamps that are in use, and their wattage. If you can’t see the rating by inspecting the bulbs/lamps, then ask whoever is responsible for maintaining them. |
| | Is the lighting performing its task? |
| | Are the luminaries clean and bulbs/lamps working? |
| | Are the luminaries effective at casting light into the occupied space, or do they waste light? |
| | Has light output deteriorated with age, suggesting lamps need to be replaced? |
| | How are the lights controlled/switched? |
| | Do operating hours match occupancy hours? |
| | Are they on when daylight levels would be adequate for requirements? |
| | Are lighting levels adequate or excessive for requirements? Recommended LUX levels! |
| | What do you hear most often regarding lighting in this building from the occupants? |
| | Do fluorescent lamps have electro-magnetic or high frequency controls? If they flicker when they are switched on, then they have electro-magnetic controls. |

| Office equipment | |
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| | Office equipment typically accounts for more than 20% of total energy consumption in offices. The electricity they consume becomes a source of heat gain, which can result in overheating or increase cooling load. |
| | How many computers are there? |
| | What proportion of PCs and monitors automatically switch to standby if left idle, and what is the time delay? Note that "screensavers" generally don't save energy. |
| | What other office equipment is used, and does it switch to standby? |
| **Boiler plant**<br><br>Boilers are used to generate steam and hot water for space heating and process requirements. In many facilities the boiler plant is the single largest consumer of fuel energy. All boilers use a burner to deliver a mixture of fuel – the major energy input – and air for the combustion process that produces heat, which is subsequently transferred to the output medium, either steam or hot water – the major energy output. There may also be minor electrical energy input to operate auxiliary equipment, such as a blower. | |
| | What is the age and condition of the plant? |
| **Determine the need** | Document the load on the boiler – ideally an hourly profile.<br>For hot water boilers:<br>• Temperature and flow requirements.<br>For steam boilers:<br>• Flow, pressure and steam quality requirements.<br><br>*This may require examining loads downstream from the distribution system.*<br>*The load on the boiler will change as a result of other energy management actions at the point of end-use and in the distribution system – this step may need to be revised periodically.* |
| **Meet the need** | Ensure that boiler temperature and operating pressure are not significantly greater than the highest requirement. Operate at the minimum possible temperature and/or pressure.<br>In a multi-boiler plant, sequence boilers online in accordance with demand for steam or hot water.<br>Minimise the requirement for boilers on hot standby.<br>Monitor overall boiler plant performance (fuel to steam/hot water).<br>Minimise load swings and schedule demand (ideally at point of end-use) where possible.<br>Adjust boiler blowdown schedules and frequency to load and water chemistry requirements. |
| **Maximise efficiency** | Check combustion and boiler efficiency regularly.<br>Check and adjust excess air levels on a regular basis.<br>Check and adjust water treatment procedures on a regular basis.<br>Keep burner assemblies and controls adjusted and calibrated.<br>Maintain seals, air ducts, breeching, and access doors to ensure airtightness.<br>Ensure that boiler and piping insulation is up to standard. |
| **Optimise supply** | Relocate combustion air intake or de-stratify boiler room air to take advantage of waste heat to preheat combustion air.<br>Install a non-condensing economiser to capture heat in flue gases.<br>Install a flue gas condenser to capture additional heat in flue gases.<br>Reclaim heat from boiler blowdown. |

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| **HVAC**<br><br>HVAC systems are designed to provide a comfortable, safe and productive environment for occupants in the form of adequate ventilation and comfortable temperature and humidity levels. In this section the scope of HVAC will be limited to the control and delivery subsystems. The heating, cooling and humidification equipment, which provides the energy source for HVAC, is covered elsewhere in this check list.<br>HVAC systems can be quite complex, with a wide range of operating modes depending on the outdoor ambient conditions, occupancy schedules, and seasonal and other factors. It is therefore essential to have a good understanding of how a system is designed to operate as well as how it is actually operating. You can often achieve substantial savings simply by restoring a system to design conditions. Historical operational information from logbooks or interviews with operators can be quite useful in evaluating a system over a full range of operating conditions. | |
| **Determine the need** | Document the load on the system – meter cooling input.<br>Evaluate the space requirements – schedules, occupancy, temperatures, and humidity, exhaust and ventilation.<br>Carefully consider any effect energy management opportunities (EMO) might have on the environmental quality of the conditioned space.<br><br>*The load on the system will change as a result of other energy management actions at the end-use – this step may need to be revised periodically.* |
| **Meet the need** | Ensure that supply temperature and humidity are not significantly greater than required. Operate at the minimum possible temperature, humidity, fresh air % and/or airflow. Consider ventilation on demand.<br>Monitor overall HVAC performance (energy input to conditioned space).<br>Minimise load swings and stagger demand and start-ups (ideally at point of end-use) where possible.<br>Make use of free cooling where possible.<br>Schedule systems and/or temperatures to match occupancy.<br>Ensure that controls are operating properly and calibrated regularly.<br>Consider control upgrades to direct digital, offering more flexible control of systems to loads, provided that underlying systems are capable of the appropriate modulation.<br>Use variable speed drives where operating hours, conditions and economics dictate.<br>Install local air treatment units (e.g. electronic air cleaners, activated charcoal odour-absorbing filters, high-efficiency filters) to reduce the need for general exhaust. |
| **Maximise efficiency** | Regularly check mechanical maintenance parts (fans, bearings, alignment, etc.).<br>Ensure that air filters and ducts are clean.<br>Use EE motors where operating hours, conditions and economics dictate.<br>Insulate distribution system – pipes, ductwork.<br>Maintain seals, air ducts, breeching, and access doors to ensure airtightness.<br>Ensure that duct and pipe insulation is up to standard. |
| **Optimise supply** | Reclaim exhausted heat and cooling.<br>Use thermal storage in cooling systems to optimise purchase of electricity. |
| **Compressed air systems** | |

<table>
<tr><td colspan="2">Compressed air has been termed the third utility, often with operating costs close to those incurred for electricity and thermal energy. The compressor used to generate and treat compressed air accounts for a large but necessary portion of the electrical load in most industrial facilities.<br>Leaks of compressed air are the most common and major cause of excessive cost, typically accounting for about 70% of total wastage. Energy losses in a poorly maintained air system arise from the requirement for additional energy to overcome equipment inefficiencies, since the air may not be delivered at the correct pressure.<br>Long-term cost of compressed air generation is typically 75% electricity, 15% capital and 10% maintenance. Simple, cost-effective measures can save 30% of electric power costs. Consequently, the effort to make a compressed air system energy efficient can pay off handsomely.</td></tr>
<tr><td>Determine the need</td><td>Is compressed air needed at all? Can another energy form be used? (Especially air motors and cooling!)<br>Inventory the need for compressed air in terms of:<ul><li>Flow requirements (SCFM or Nm$^3$/min.).</li><li>Pressure requirements.</li><li>Quality (temperature, moisture content, oil content, etc.).</li><li>Point(s) in the distribution system.</li></ul>Document when compressed air is required.<br>Is the real demand for compressed air growing – or are leaks just multiplying?</td></tr>
<tr><td>Meet the need</td><td>Implement a plant-wide awareness program for compressed air management.<br>Eliminate leaks:<ul><li>Use an ultrasonic leak detector (or your own ears when there is no noise from production) to track down leaks, and then fix them.</li><li>Isolate appliances and equipment with valves when not in use.</li></ul>Manage end-use:<ul><li>Eliminate unnecessary uses (floor sweeping).</li><li>Consider intensifying nozzles instead of simple cut-off pipe nozzles.</li></ul>Minimise main supply pressure.<br>Avoid pressure reduction at point of end-use, segregate large low-pressure uses and provide separate low-pressure supply – consider high-pressure blowers.<br>Use treatment appropriate to quality requirements – segregate low-volume, high-quality users and provide separate supply.<br>Ensure that controls for treatment (drying) are not set lower than required.<br>Ensure that compressor capacity on-line follows demand for air:<ul><li>Base-load compressors with poor capacity control (throttling) – check motor load when air delivery from compressor is low.</li><li>Sequence compressors to ensure that unit with best capacity control follows the load.</li><li>Ensure that idling compressors shut down promptly.</li></ul>Optimise the compressor plant with properly sized receivers, demand control devices, and comprehensive system control.</td></tr>
<tr><td>Maximise efficiency</td><td>Ensure that inlet air temperature is as cool and dry as possible – use outside air during cold seasons.<br>Ensure that inlet filters are clean with minimal pressure drop.<br>Ensure that filtration and treatment equipment impose minimal pressure drop.<br>Ensure that line sizing is appropriate to flows to minimise pressure drop.<br>Ensure good piping practices to avoid excessive pressure drops at T-joints, elbows, unions and other fittings.</td></tr>
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| | Ensure appropriate compressor room temperature.<br>Consider replacing compressor with a more appropriate, newer and/or more efficient unit – variable speed drive (VSD). |
| **Optimise supply** | Install the simplest form of heat recovery possible to reclaim heat rejected from the compressors – either water or air-cooled. |
| **Cooling/Refrigeration systems**<br><br>Refrigeration systems are designed for one basic purpose: to move heat from a lower temperature (heat source) to a higher temperature (heat sink) medium, using a transfer fluid (refrigerant). Since this is the reverse of the natural direction of heat flow, energy input is required, usually in the form of electricity. Depending on the amount of heat to be moved, the cost of refrigeration can be significant.<br>Refrigeration systems are relatively complex, and their efficiency is affected by operating conditions. While a system is typically rated for a particular maximum or design cooling load, it usually operates for most of its life at some fraction of that output, or at partial load. The efficiency of a cooling system can vary significantly with load, depending on the capacity control method employed. Consequently, it is important to evaluate system performance and efficiency over the range of actual loads.<br>The energy required to run a cooling system is proportional to the temperature difference between the heat source and heat sink. Therefore, reducing the temperature difference between the cooled medium (e.g. refrigerated storage) and the condensing (e.g. cooling tower) temperature has a substantial effect on energy input to the system. Various measuring devices, such as a wattmeter, thermometer, psychrometer and pressure gauge, can be useful in evaluating the cooling efficiency of refrigeration systems. | |
| **Determine need** | Document the cooling load and temperature requirements – ideally with a profile.<br>Consider the varying requirements for temperature:<br>• In process, possibly by product or process stage.<br>• In HVAC, according to season and occupant requirement.<br><br>*Consider the effect that other energy management actions at the point of end-use may have upon the needs of the system – this may change over time.* |
| **Meet the need** | Use conservative practices at the point of end-use to minimise the cooling load.<br>Calibrate controls and set temperatures to highest acceptable levels.<br>Avoid, if possible, simultaneous heating and cooling.<br>Ensure appropriate capacity control of refrigeration systems:<br>• Controls for multiple units.<br>• Modulation (without false loading) for single units.<br>Avoid the use of hot gas bypass for capacity control.<br>Investigate the possibility of raising the evaporator temperature through such actions as chilled water reset to higher temperatures. Use as high a temperature as possible while still maintaining cooling requirements.<br>Ensure that defrost controls are set properly and review the setting regularly. |
| **Maximise efficiency** | Ensure that all heat exchange surfaces are regularly cleaned and maintained.<br>Lower condensing temperatures by ensuring the free circulation of air around condensing units and cooling towers.<br>Ensure that cooling towers are effectively maintained to obtain the lowest water temperature possible.<br>Investigate floating head pressure or liquid pressure boost to reduced condensing temperature and pressure on a seasonal basis.<br>Replace compressors with high efficiency units (COP). |

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| **Optimise supply** | Use thermal storage to optimise operation of cooling systems and optimise the purchase of electricity on a time-of-day basis.<br>Utilise de-superheaters to recover heat rejected from condensers.<br>Consider deriving "free cooling" capacity directly from cold open air (e.g. in wintertime), thus limiting compressor use and therefore electricity consumption.<br>Consider using only water as refrigerant for process cooling water. |
| **Fan and pump systems**<br><br>Fan and pump systems share many similar characteristics and as a consequence may be analysed in similar ways from an energy perspective. Each is typically driven by a motor, either directly or through a belt or gearbox. Both systems frequently use centrifugal devices to create motion in fluid or air, and, as a result, both systems are governed by a set of rules known as affinity laws. The affinity laws describe the relationship between speed, flow, pressure and power required. | |
| **Determine the need** | Determine the requirement for air/water flow, possibly as a profile over time.<br>Determine the range of pressures that the fan/pump will need to overcome.<br>Determine if the need for flow is fixed or variable.<br>Determine the duration of the need for flow (hours per day). |
| **Meet the need** | Provide and use manual control of fans/pumps.<br>Automatically control operating times of fans/pumps.<br>Conduct an air/water balance with qualified contractors.<br>Eliminate or reduce throttling as a flow control means.<br>For fan systems with a fixed flow requirement, reduce flow rates to the requirement by:<br>• Reducing fan speeds by sheave changes.<br>• Shutting down extra (backup) fans.<br>For pump systems with a fixed flow requirement, reduce flow rates by:<br>• Changing or trimming pump impellers.<br>• Shutting down extra (backup) pumps.<br>For fan or pump systems with variable flow requirements, vary flow by:<br>• Using a two-speed motor.<br>• Using a variable speed drive.<br>Eliminate leaks in the ductwork and pipework. |
| **Maximise efficiency** | Provide proper maintenance for fans and pumps:<br>• Lubrication.<br>• Belts and pulleys.<br>• Pump and fan overhaul and cleaning.<br>Reduce pressure drops or pipework/ductwork resistance by:<br>• Cleaning interior of pipes/ducts.<br>• Maintaining filters/strainers.<br>• Using efficient ductwork/pipework practices.<br>Select and install a more efficient pump or fan:<br>• More appropriate design for the application.<br>• New equipment/technology.<br>Install a more efficient motor. |
| **Optimise supply** | Consider the use of small steam turbines, typically in place of pressure reducing valves, to drive large fans and pumps (i.e. boiler feedwater pump, boiler forced draft or induced fan). |
| **Process furnaces, dryers and kilns** | |

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| Process furnaces, dryers and kilns are used in such diverse applications as melting metal, drying wood, evaporating water, and manufacturing lime, bricks and ceramics. Some facilities are constructed and operated solely for the purpose of a single heated manufacturing process. Consequently, the furnace could be the single largest consumer of fuel energy. All non-electric furnaces use a burner to deliver a mixture of fuel and air for the combustion process that produces heat, which is subsequently transferred to the product either directly (in the combustion chamber) or indirectly (through a heat exchanger). There may also be electrical energy input to operate auxiliary equipment such as blowers and draft fans. As with boilers, it is important to evaluate furnace performance and efficiency over the range of actual or partial loads. Unlike boilers, there is usually no large heating distribution system with its accompanying losses (i.e. the end-use of the heat is in the furnace).<br>Maintaining the optimum ratio of fuel to air is critical for the efficient operation of fuel-burning furnaces. A lack of air leads to incomplete combustion, resulting in losses of combustibles in the flue gases (smoky flame). Excess air needlessly increases the dry flue gas losses, as indicated by higher flue gas temperatures. In addition, the excess air entering the furnace must be heated, increasing energy losses. The temperature of the flue gas also depends on the effectiveness of heat transfer to the product being processed and is a good indicator of the condition of internal heat transfer surfaces. In some cases, a large amount of excess air is required to maintain product quality. In that case, heat recovery should be considered. The portable combustion analyser is a useful tool for gauging the combustion efficiency of process furnaces, dryers and kilns. | |
| **Determine need** | Document the load on the furnace, dryer or kiln – perform an energy balance on heat loss from the unit itself.<br>Evaluate the process requirements in terms of product loading and thermodynamic requirements.<br>Carefully consider any effect an EMO might have on the quality of the end product. |
| **Meet the need** | Ensure that process temperature is not significantly greater than the highest requirement. Operate at the minimum possible temperature and/or airflow.<br>In a staged system, sequence burners on-line to follow demand for heat.<br>Minimise the requirement for furnaces on hot standby.<br>Monitor overall process heating performance (fuel to product).<br>Minimise load swings and schedule production to optimise use of furnace, dryer or kiln capacity when possible.<br>Review operator procedures for minimal energy use practices. |
| **Maximise efficiency** | Regularly check combustion efficiency.<br>Check and adjust excess air levels on a regular basis.<br>Keep burner assemblies and controls adjusted and calibrated.<br>Maintain seals, air ducts, breeching, and access doors to ensure airtightness.<br>Relocate air intakes to ensure driest possible air is used in kilns.<br>Ensure that surface insulation is up to standard.<br>Install electronic controls for combustion and temperature control. |
| **Optimise supply** | Relocate combustion air intake or de-stratify plant air to take advantage of waste heat to preheat combustion air.<br>Install a non-condensing economiser to capture heat in flue gases.<br>Install a flue gas condenser to capture additional heat in flue gases.<br>Reclaim heat from product cooling. |
| **General process equipment** | |
| **In general** | Are auxiliary equipment, motors and conveyors switched off when the production lines are shut down? |

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| | Are motors for pumps, agitators, circulation etc. system-demand controlled and equipped with a variable speed drive (e.g. frequency converter)? |
| | Are there many displays and computers on standby? |
| | Are there heaters, heating elements, fan heaters, shrinkage oven etc., which are in operation without demand? |
| | Are the processing plants (furnaces, tubs, silos, tanks etc.) properly insulated? |
| | Are the processing plants kept on service temperature for no reason even though there is no production? |