# Sustainable Design – Specification of Requirements – New Production Equipment/Machinery

Old and obsolete machines are often disproportionately expensive to run, and the energy costs are correspondingly high. Additionally, it can be very costly to maintain old machines, and it can often be difficult to find spare parts. There can thus be many good reasons to invest in new machinery.

The list of requirements specifications is aimed primarily at the company's technicians and operators, which, based on the requirements specification, can make a very accurate assessment of the machines it would be optimal for the company to invest in.

| Check out the following | What should you specifically do?/Key Questions |
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| **The demand in general** | |
| **Demand Analysis** | Check on the existence of a well-documented demand analysis that incorporates all of the rationales for the desired capacity, degree of automation, technology, the desired operating pattern etc. |
| | Make sure that there are estimates of how much time the equipment spends in each mode: Full production, partial load, idle, cleaning time (CIP/SIP), set-up for batch change and maintenance. |
| **Capacity** | Carefully consider the capacity required by the equipment. The dimensioning should preferably be designed for both current and future production volumes and quality demands and preferably without operating the equipment at partial load. Generally speaking, partial load operation has lower specific energy efficiency (energy/unit of product) than at full load. |
| | If the machine or process equipment is part of a longer production line, the capacity should be adjusted to fit the total line as well as possible, e.g. by parallel connection of multiple units, if the load on the line varies greatly. |
| **Technology Selection** | Be sure to examine the new technology available on the market, especially if the existing equipment is of older date. Ask different vendors, specify energy requirements for the suppliers, and if possible use Discussion Groups or Networking Groups for both inspiration and to influence suppliers. |
| **Efficiency** | |
| **Energy Efficiency** | Set up requirements for low energy consumption in embedded devices:<br>• You will need energy efficient pumps, fans, mixer etc.<br>• All motors must be energy class IE2 or better.<br>• Make demands on energy efficient gear systems. Avoid worm gears and variable belt drives.<br>• Suggest use of low speed synchronous motors instead of gears<br>• Require energy efficient heating methods, e.g. where heat is placed precisely on site.<br>• Use actuators driven by electricity rather than compressed air, where possible. Compressed air actuators react more quickly, but consider if this is necessary.<br>• Require good technical insulation of hot and cold surfaces, e.g. pipes, valves, heat exchangers, vessels and ovens.<br>• Suggest use of internal heat recovery between cold and warm flows, primarily in processing equipment. |

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| **Shut-down Procedures** | Make requirements that all machinery and equipment can be switched off completely (zero energy) outside production hours. Both power consumption and external supply must be shut off completely, e.g.:<br>• Control (PLC) must be able to handle the shutdown of power supply.<br>• Main Supply lines for compressed air can be shut off automatically.<br>• Production related lighting, monitors, printer etc. |
| **Heat Recovery** | Investigate the possibility of using waste heat from machines and process equipment located elsewhere in the factory. Especially high temperature waste heat (+40˚C) is attractive for preheating processes, space heating, cleaning water or other purposes. Water-borne waste heat is easier to transport between individual productions areas, but heat from ventilation exhausts can also be recycled. In many cases waste heat can be reused through the use of heat pumps. If the heat cannot be reused, it must be removed as close to the source as possible, e.g. by encapsulation of hot spots and use of separate exhaust ventilation. |
| **Accessories** | Require low energy consumption in auxiliary equipment, e.g. LED lighting on manual workstations, low power consumption on control panels and energy efficient power supplies in process controls. If possible, associated equipment should shut down completely with the machine and/or process equipment. |
| **Noise and Vibration** | Avoid noise and vibration as far as possible. |
| **Cleaning** | Require that the machine/equipment is as easy to clean as possible, in order to avoid unnecessarily large quantities of hot water and chemicals for this purpose. This especially includes process equipment that is cleaned automatically through CIP (cleaning in place). Procedures for cleaning must be adapted to the machine's current needs. |
| **Automation** | |
| **Mode Signal** | Require that the equipment can signal what condition it is in (full load, part load, idling, etc...). These signals should be used to control peripherals in an energy efficient manner, and as part of energy management and maintenance. |
| **Timer Control** | Systems should be installed for timer, clock and calendar control of production equipment, in order to turn it off outside working hours. If this is not possible, manual shutdown of the machines should be made as easy as possible, preferably from one single control-switch. |
| **Shut-off** | Completely isolate as many external supplies (compressed air, cooling, etc.) as possible when the individual machines are not in use. As far as is possible, this should be completed automatically, and preferably on the main supply lines. |
| **Frequency / Speed Converter** | Be sure to use inverters for partial load regulation instead of variable gears, dampers and valves. |
| **External Supplies** | |
| **Heating** | Never make requirements for temperatures from external heat supplies that are more than 10˚C higher than the target heating temperature. This increases the potential for heat recovery from other systems, and/or use of hot water instead of steam.<br>Avoid as far as possible the use of steam and electricity for heating purposes, since they are both expensive and associated it with greater $CO_2$ emissions than heating from district or central heating. |
| **Cooling** | Never make requirements for temperatures of the external cooling supply that are more than 3°C less than the target cooling temperature. If possible use free cooling from cooling towers or direct cooling with outside air. |

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| | If compressor cooling is required, make sure that it operates at the highest evaporation temperature possible. Also use exchangers, which are sized large enough to allow the coolant to achieve a good temperature rise, so as to avoid unnecessarily large amounts of cooling liquid to be pumped around. |
| **Compressed Air/Vacuum** | Make sure that the pressure level is as low as possible, and that vacuum as far as possible be avoided. Consider options to shut-off the systems when there is no consumption. |
| **Commissioning and maintenance** | |
| **Access** | Ensure good access to individual components in order to maintain low energy consumption associated with maintenance, e.g.:<br>• Replacement of defective parts, motors, pumps, etc.<br>• Possible replacement of technical insulation.<br>• Access to compressed air and vacuum pipework for repairing leaks. |
| **Handing-over Procedure** | As part of the handing-over procedure there must be written procedures describing how the energy should be measured and recorded. All main internal energy flows and external supplies should if possible be checked as part of commissioning. |
| **Operator Training** | Require operator training, with focus on energy efficient behaviour. |
| **Maintenance Procedures** | Suppliers must deliver correct maintenance procedures for all equipment. Clarify internally who is responsible for compliance with these procedures. Require spare parts lists so that future replacement parts will be the same energy efficient type as delivered. |
| **Compressed Air** | Perform regular leak detection with listening devices and seal all subsequent leaks. Pay particular attention on hose couplings, hoses, clamps, quick connections, pressure gauges and seals in the valves manifolds. |
| **Transmission** | Inspect belt transmission and change belts as stated in documentation. Gears and other transmission parts must be lubricated and have oil-change as stated in documentation. |
| **Reduction Valves, etc.** | Inspect and tighten regularly all reduction valves, water traps, inspection windows, stop-valves, distribution manifolds, solenoid valves, and other components throughout of the production system. |
| **Energy Management** | |
| **Meters** | Be sure that any machine which will be a significant energy consumer is equipped with separate energy meters – including flow, pressure and temperature meters, in order to closely follow the consumption and efficiency throughout its total lifetime. |
| **Supplier Information** | Make sure that the suppliers give the necessary information about the correct energy consumption (electricity, heating, cooling and other external supplies) of the equipment. Pay special attention to whether the correct information about compressed air consumption has been given. This will make it easier to estimate operating costs used in the decision making and selection of machine/equipment and supplier. |
| **Efficiency** | Monitor the efficiency of the machinery by comparing the energy consumption correlated with production quantities. |
| **Idle Consumption** | Monitor idling consumption, as this may reveal defects that would not otherwise be discovered. |

*Reference: This document was developed by Mr. Bo Kuraa, BKU Consult*