Solar Power for Metal Finishers

By Helmut Hertzog
of Atlantic Solar

The days of cheap abundant electricity are over ! This article forms part of a series of articles where we will explore the possibility of using alternative energy sources in industrial applications and specifically look at whether using electricity is the best energy medium for thermal heating applications.

Metal finishing and electroplating businesses are big consumers of electricity, with the cost of electricity easily representing between 6% and 8% of operating cost. Given the most recent increase in electricity tariffs and the possibility of erratic supply down the line, business managers need to do a careful analysis of their energy consumption, and start looking at different alternatives. No business can merely continue to pass the increasing cost of energy off to the consumer as it starts threatening their viability and they may even become vulnerable to importers that source plated components cheaper overseas.

It all starts with the energy balance. It is vitally important to know where energy is used in your business and what it is used for in order to understand what alternatives could be available. In electroplating businesses for instance between 40% and 50% of energy used is consumed by electrical rectifiers, a further 35% to 45% of energy is used for thermal heating of the various process solutions. Often between 2% and 5% is used for lighting and the balance is used for pumps, air conditioners, motors, aerators and so forth.

A further 35% to 45% of energy is used for heating of process solutions

Historically electricity was cheap and abundant and therefore many of these businesses standardised using electricity as a single energy source for all their applications. Tank and thermal heating is often achieved using immersion elements similar to a regular geyser element. The fact however is that other forms of thermal energy such as solar energy or LPG, may be a more efficient or affordable way of heating liquid solutions.

Traditionally managers did not consider refurbishing or replacing equipment with newer more energy efficient equipment if the investment time frame or payback was over three years. The fact is that many options to reduce the cost and reliance on electricity in such businesses exist, but the typical investment time frame is often 5 to 7 years. This obviously changes as the cost of electricity increases and makes taking a look at alternatives worth the while.

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Something that must be understood at this time is that energy can not be easily or cheaply stored. Solar energy for instance, be it electrical or thermal, should be used when it is generated rather than being stored. This has the implication that solar energy is best used as an auxiliary source of energy in conjunction with electricity or LPG. Depending on the scale of implementation and the budget, it is very difficult to rely on solar energy as a sole source of energy. This also depends on the type of business. If the business operates only during daylight hours when solar radiation is available, solar could form a bigger part of the energy mix compared to a business that works around the clock.

Many utilities are now also changing their billing regimes to charge at the peak rate rather than for pure consumption. This has the implication that it is more cost efficient to have a modular approach to energy consumption using more smaller heating elements or rectifiers or a mixture between electrical heating and solar heating or LPG for that matter. This helps to smooth the pattern of usage in order to avoid big spikes. If a business is charged at peak rate and they have a single peak once a day they pay for all their consumption at the higher peak rate, not just that part when consumption peaks.

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It is also important to appreciate the different types of alternatives available. Solar energy has two main divisions being Solar Photovoltaic and Solar Thermal. Photovoltaic (PV) energy is electrical energy generated through a silicon crystalline or thin film module whereas thermal energy is the use of infra red heat from the sun to heat a medium, be that air or a liquid such as water or oil. Likewise , a medium can be chilled by circulat-

ing it through a thermal collector at night as the collector is almost equally efficient in absorbing heat during the day or dispensing heat at night. Another alternative is to use geothermal heating or cooling, which is the latent energy harvested from the earth core.

A medium can be chilled by circulating it through a thermal collector at night

The capital cost of generating electricity with PV is generally high but good quality modules will last for 25 years. Batteries however need more frequent maintenance and replacement which needs to be costed into the exercise. Due to the high energy consumption of electro-plating rectifiers it is not advisable to use a photovoltaic array to generate electricity in 12v DC, convert it to AC with an inverter and then back again to DC through a rectifier. Depending on the specific load required it could be viable to use DC current generated with PV to perform certain plating tasks. As a general rule PV is best used in low load applications as the array cost remains quite high but a case by case analysis may show opportunities in this area. It is for instance more efficient to plate small parts in a smaller tank with a smaller rectifier or appropriate load. Using a 5kW array to draw only a small load for a small job is not efficient and should not be considered. When using PV energy it is very important to match the requirement with the supply and not to waste.

Motors, air conditioners or applications with a high induction load on start up are not suitable to run on solar PV energy as a very big array is required to generate a big load only for a short period while the motor starts up. The rest of the time the array and inverter sits idle implying a waste of capital. This also influences the size of inverter and storage needed, but if it is a smaller part of a large installation these issues are less crucial. The scope and size of the project does have a material effect on the way the target load or application is determined.

Lighting and computers on the other hand are ideally suited for powering with PV energy as most new energy efficient lights such as modern compact florescent or LED lights do not have the same high induction load requiring a smaller system. Many new and exciting developments are coming to the market, varying from ultra low consumption compact fluorescent lights (CFL) to light emitting diodes (LED) to hybrid lighting systems

Lighting and computers are ideally suited for powering with Photo Voltaic energy

that channel direct sunlight into a building through a series of optic fibre cables. It does however mean that a certain amount of retrofit to existing infrastructure will be required.

One of the low hanging fruits and more easily implementable technologies is thermal heating. There are a host of different technologies and generation forms and again the specific application will dictate the best way to use the energy. One could use a simple domestic solar water heater for the bathrooms or even an array of collectors and bulk storage for heating process fluids. The design of industrial systems is more complex than ordinary domestic systems but the concept still remains similar. When it comes to deciding what type of system to use there are several design concerns and there are different types of collectors such as flat plate, vacuum tube, parabolic trough, Fresnel concentrators, etc. In the next article we will discuss the pros and cons of these and look at which generation technology is best suited for different applications.

Thermal storage is cheaper than electrical storage but often has a space constraint. In order to heat 2500 litres of water for a 24 hour shift and store that for later use you would need a storage vessel of considerable size and roof space to mount the collectors. Here there are different ways of setting the system up. If process heat of 40^{O}C is required it may be better to store the heat at a higher temperature drawing off what is needed but then the cost of insulation and keeping that heat will play a role.

When considering thermal heating even LPG gas is an option but it must be noted that the cost of LPG has risen far more than the cost of electricity in last 3 to 4 years. There are cases when this makes sense especially when it is a consideration of available alternatives.

Ensuring that the system is designed to operate efficiently and that waste is minimised is of utmost importance. In times gone by electricity was cheap and we often wasted energy. Now we need to change our way of thinking. An example of what can be done is to ensure that process tanks are properly insulated on the outside and that heat loss through the surface in minimised. It is important to steer away from old habits using cheap

electricity to heat a medium and not bother with preserving that heat. Avoid having lights burn at desks or in rooms while nobody is there. For this motion sensors can be used to actively turn lights off when not needed. Match the usage of items being plated in tanks with the appropriate load from the rectifier. In years before, the capital cost of such efficiency steps was considered to be too expensive, but that is no longer the case.

Tremendous opportunities exist to use alternative energy forms such as solar PV and solar thermal in an electroplating business but it must be understood that there are several variables that cannot be controlled and that solar energy should be considered as an auxiliary energy source and not a permanent replacement of electricity. Solar thermal energy can be used to reduce the heating cost of process fluids and often the payback on a system of this nature is between 4 and 7 years.

As a general rule photo voltaic systems cost in the region of R100 per watt capacity and thermal solar heating cost in the region of R55 per litre capacity depending on the size and complexity of the system. Very often the bigger the system the lower the unit cost. When adding solar energy to the total energy mix it is possible to design a system so that it is modular and the shift away from electricity is done over a period of time negating the necessity for huge upfront investments.

In the next article we will explore the different types of solar energy generation systems, look at the more technical issues and the best application of each system.

Helmut Hertzog is the managing director of Atlantic Solar, a company with a 25 year history in the solar industry in South Africa. Helmut has a commercial background with an MBA from the UCT Graduate School of Business. He has been with Atlantic Solar since 2003 where amongst other things he constantly drives research on new and innovative applications of solar energy.