

Are you buying more power than you think?

Electricity consumers are being force-fed more power than they need because of a technological oversight. As Michael Gunter explains, the problem is solveable and could reduce costs and greenhouse gas emissions

Power surges are dramatic, some times terrifying events. Appliances and computers, microwaves and home security systems are destroyed in a flash. Heated wrangling about liability between customer, insurer and power company often reaches the door of the Ombudsman. Millions of dollars in compensation or insurance claims are paid each year.

But there is another sort of financial damage that goes completely unnoticed: a steady trickle of excess energy can be fed into many homes 24 hours of every day, ending up as an inflated electricity account at the end of each quarter, a few more light globes or halogen lamps purchased at the supermarket, and increased pollution from power stations. These excess costs are due entirely to the fact that the average voltage experienced by many, probably most, electricity customers is significantly more than the official 'nominal' voltage of 240 volts. Most electricity utilities, both retailers and distribution businesses, when queried about this tell us that the supply voltage has no effect on customers bills, but a mounting body of evidence collected by the Alternative Technology Association (ATA) says otherwise.

Basic electrical theory tells us that power is proportional to voltage-squared. In other words if you double the voltage, then the current doubles as well, so you can supply four times as much power to an electrical device. There are exceptions to this rule, and in the home, these include induction

motors such as those found in washing machines and fridges.

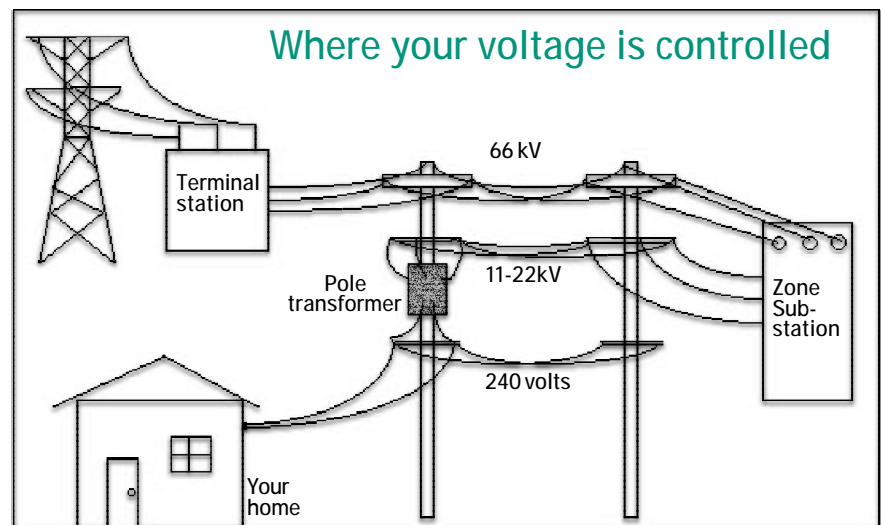
Electricity distribution

If you trace back along the wires that supply electricity to your house, you will come to a grey transformer, usually up a power pole, and usually within a few hundred metres of your house. It is supplied by high voltage (HV) wires at 11,000 volts (city) or 22,000 volts (rural). Tracing these HV 'feeder' wires on the big insulators back further leads you to the zone substation: this is where your voltage is regulated and adjusted. If every customer turned off all power, the voltage through the system would be whatever was set at the zone substation: typically 23,320 or 11,660 volts for the HV wires, and 254 volts for the LV wires. At times such as heatwaves or very cold weather, when customers are all using

The nuts and bolts

The fundamental nature of electrical energy is described by a simple formula $P=VI$ or power(P) is voltage(V) times current(I). But the current for most loads is also proportional (or very nearly so) to the supply voltage, ($I=V/R$ where R is the electrical resistance of the load). Induction devices like fridge and washing machine motors are exceptions to the rule, as they do not behave in the same way as resistive (impedance) devices like radiators and light globes.

lots of energy, the system has a considerable voltage drop along the HV and LV wires because they do have considerable electrical resistance. The distribution system makes allowance for this, and is designed to provide adequate voltage to customers furthest from the zone sub-



Voltage is controlled at two points in the transmission system: the terminal substation and zone substation. The pole transformer converts voltages down to 240 volts.

station even at these times of maximum electricity use. The lowest official allowable voltage is 225.6 volts at your fuse box and 213.6 volts at the power point (wall socket). All appliances sold in Australia are certified safe to operate over the full voltage range: 213.6 to 254.4 volts.

Many zone substations have devices called on-load tap changers or OLTCs: they allow for voltage adjustment under varying load conditions. OLTCs can be programmed to keep the HV feeder at a set high voltage under all load conditions: all customers will get voltage around 250 volts at 3am to 5am each morning if this control profile is used¹.

Retailers maximise sales

If your house always gets 250 volts instead of 240 volts, the extra voltage can cause many household loads to draw 8.5 per cent more instantaneous power. Over time, this is an 8.5 per cent increase in energy used, an 8.5 per cent increase in the power bill, and an 8.5 per cent increase in the pollution associated with electricity production. This assertion really seems to boil the blood of many electrical engineers: they remind us there are 'controlled loads' such as computers, ovens and heaters with very sensitive thermostats, where the energy used will barely, if at all, be affected by the supply voltage.

However, a careful examination of modern households reveals that many heaters lack an effective thermostat, and there are many hidden loads in cordless phones, answering machines, clock radios, radio-cassettes, microwave ovens, televisions, VCRs and fridge doors to name a few. It has been calculated that these phantom loads are the third largest category of load in many domestic and commercial situations. They often remain plugged-in 24 hours a day, and are 'uncontrolled' precisely because the householder is unaware of their



Photo: Michael Linke

power usage, or because their function requires constant readiness. The power they use almost always follows the voltage-squared formula: the higher the voltage, the higher the running cost.

What conspiracy?

Representing the ATA as energy policy spokesperson, I recently engaged in some internet newsgroup discussion forums, and was accused by some elec-

trical engineers of hatching a 'conspiracy theory' about the behaviour of electricity utilities regarding voltage settings. A similar response was earlier forthcoming from an Australian professional committee. The ATA has no evidence of conspiracies in the electricity industry. The technical statements of industry professionals and their companies are presumed to be honestly held beliefs, which may have been historically

accurate, or which now apply only in very specific situations. They need to be re-tested on modern loads in modern houses and offices.

Professional silence

Academics and professional bodies are silent. Engineers within the power companies are bound by commercial confidentiality clauses in their employment contracts not to say anything which could financially damage the employer. Even professionals who rely on contract work cannot afford to 'rock the boat', or the contract work may dry

30% cost hike forecast

Standards Australia has recently put out a draft standard AS 2926 for public comment (closed 30 April 1999). The standard proposes that Australia will manufacture appliances with a wattage rating measured at 230 volts for appliances sold from 2003. Example: A 1000 watt single-bar radiator is presently designed to deliver that power at 240 volts of supply, which we all assume we are getting now. After 2003, it will have to be rated at 230 volts and will have a slightly lower resistance (impedance) than at present, so that the 1000 watts output can be achieved at the lower voltage. Where's the rub? The supply voltage upper limit will not change: what is now 240 volts plus or minus 6 per cent is to become 230 volts plus 10 per cent or minus 6 per cent, so power companies will still be allowed to supply 253 volts continuously to customers if they deem it necessary. At 250 volts your new 230 volt radiator that you might reasonably assume is running at 1000 watts is actually running at 1180 watts, which gives 18 per cent more heat but also gives the electricity retailer 18 per cent more revenue from that appliance whenever it is switched on. When 10 per cent GST is added, the running-cost blows out to a whopping 25 to 30 per cent* increase, depending on whether or not the benefits of abolishing the wholesale sales tax are passed on to all consumers.

up. Despite the ATA's attempts to have a technical debate with the engineering profession and the industry, blanket denial of the problem has been the almost universal response so far.

Perhaps the worst thing to realise is the loss of independence of our academic institutions, now so dependent on the corporate dollar. Where can the governments and the Australian Competition and Consumer Commission turn to get independent expert opinion? The federal government says it cannot afford to fund the universities. From the public's perspective, it would appear we cannot afford not to have independent experts.

Luckily, a lone Swedish engineer has responded on a newsgroup forum with a reference from an official Institute of Electrical and Electronics Engineers publication². The article proves that in 1993 increased supply voltage did increase energy sales. The authors demonstrated 'voltage dependency' of the power usage, energy requirement and running-cost of loads. For a mix of load types, the factor was close to linear, but some loads were identified as following the 'voltage-squared' law.

Low income groups to be hit hardest

The people with the fewest choices about energy usage are the poor. Renting, being on a pension, or being unemployed all tend to correlate with the use of electricity for heating and cooking. Thus the effects of chronic 250 volt supply fall most heavily on the most disadvantaged in the community. Having to buy and replace more light globes, which wear out faster with higher voltage, is an added burden. Auditors-General may need to look into the excess costs to state budgets being incurred by winter energy concession schemes as a result of the 250-volt effect.

Customer equity: 235 volts at night

If the HV feeder voltage at zone substations were adjusted downwards at times of light loading, there would be customer savings through less energy wastage. The distributor (network owner) running its system in this fashion could expect praise from customers on economic and environmental grounds, but would not be very popular with the retailers, who would stand to lose considerable revenue. Each electricity business is actually two independent businesses under the one name: the distributor (owner of the poles and wires) and the retailer. So the distributor could just tell the retailer to 'go jump', citing the clear regulatory requirements of commercial independence.

So why are most of us getting 250 volts at 4am every morning? Could it be that the industry regulators are not doing their job in protecting customers? Have they been misled by industry 'experts' on the effect of a 250 volt supply? Is the claimed independence of network owners (distributors) from retailers just regulatory double-speak? Should consumers be compensated for several years of high voltages and poorly programmed OLTCs? The time seems to have arrived for the industry to be called to account.

Burning less coal

Voltage reduction would significantly reduce electricity demand at night. My back-of-envelope calculations suggest it could be by as much as 100 megawatts for the state of Victoria alone. Some coal-fired, base-load generating units may therefore become redundant, or fewer new ones will have to be built in the future. Peak daytime load can be met by an increased proportion of cogeneration, biomass and wind energy.

Rising nocturnal demand

The published industry data speaks for itself: in 1985 the average 4am to 5am system demand in Victoria was only 2522 MW.³ In the first half of 1998 it was 4332 MW. So in 13 years there has been a 72 per cent increase in 'off peak' energy use. Over the same interval, average daily system demand has risen only 57 per cent (from 3171 MW to 4990 MW. Something in the system is using a lot more power in the wee-small hours. No wonder industry planners just have to keep on building those wonderful coal-fired power stations!

Act now

Even before the voltage gets turned down, customers can start to influence development in this direction right now by running a really serious campaign at home to reduce night-time consumption to an absolute minimum:

- Get off the night time electricity tariff and return to a daytime tariff
- Get an electrician or fridge mechanic to give you control of the heater in your fridge by installing a switch for that pesky heating element;
- Turn off everything except the fridge every night.
- Use battery-operated clocks, and don't bother reprogramming video and microwave clocks
- Replace storage electric water heater(s) with gas or solar (gas boosted).
- Never use incandescent lighting for security: install low wattage fluorescents instead.
- Ask state-based regulators and energy ombudsmen to bring the monopoly utilities under effective regulatory control. Keep on asking (politely) until they get it right.

By doing these things you may save \$50 to \$100 a year (more with solar hot

water), and make it harder for the generators to build more coal-fired power stations: their investors will have to look more to peaking plant, cogeneration, wind, solar, or hydro-electricity.

References:

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