Energy Security Target and Safeguard – Consultation Paper

Contents

Executive Summary

Background

Edge Electrons ("Edge") is a Melbourne-based energy technology company. The company was established in 2015 by Executive Chairman Richard McIndoe, formerly Chief Executive of Energy Australia and Chairman of the Clean Energy Council (2009-2011) and the Energy Supply Association of Australia (2011-2014).

Edge develops and manufactures energy efficiency and energy monitoring technologies and holds 22 global patents on a range of energy savings technologies. Flextronics (NASDAQ: FLEX), one of the largest global OEM manufacturers, acquired a 10% strategic shareholding in Edge and provides hi-volume global manufacturing and supply chain management services.

Energy Security Target and Energy Security Safeguard ("ESSS")

Edge commends the NSW Government and DPIE on the breadth of its proposed EST and ESS program, which provides national leadership in setting benchmarks for reliability, cost effective energy efficiency and peak demand reduction in the electricity sector.

Edge is pleased to provide this commentary on the DPIE Consultation Paper, together with recommendations on technology applications which will deliver further energy savings and peak demand reduction.

The principal focus of Edge's commentary will address the significant contribution available from **power factor correction technology** and **voltage regulation technology** in reducing system peak demand, providing peak demand response, and shifting peak demand.

Power factor correction (PFC) and voltage regulation (VR) are proven technologies, safety approved and commercially available for businesses and residential customers in NSW. Each technology provides major benefits to NSW customers and DSOs:

- **Significant customer savings** are delivered through continuous reduced power consumption, including peak demand saving. Dynamic PFC and VR monitoring and control allow for peak demand response and peak demand shifting.

- **Non-discretionary savings** – power factor correction and voltage regulation technologies provide firm, consistent reduction in power usage and operate independent of customer behavior. Reductions in energy consumption and peak demand capacity utilization are not based on customer discretion and behavior. They are constant and require no change in customer usage patterns. They are complementary to other peak demand reduction technologies and savings from changes in customer behavior and usage patterns.

- **Network reliability and capacity benefits:** Improved network reliability and capacity is achieved through reductions in KVA usage from dynamic PFC management and regulation of high and fluctuating network voltages, which cause high network costs, increased customer consumption and reduce network reliability.

Edge has calculated the potential NSW opportunity from implementing PFC and voltage regulation. This estimate uses real results from Edge's extensive data analysis of tens of thousands of businesses and homes interval data. Over $650M in energy savings p.a. could be realized for homes and businesses if these new technologies are given government.

	Homes	Small Businesses	Medium Businesses	Large Businesses	Total
Employees	0	5-19	20-199	>200	
NSW Count	3,059,599	46,716	13,939	1,619	
Average Consumption	6 MWh	20 - 160 MWh	160 – 250 MWh	> 250 MWh	
Average Bill	$1,500	$25,000	$75,000	$250,000	
Voltage					
Voltage savings	$135	$2,250	$6,750	$22,500	
Voltage opportunity	$413,045,865	$73,577,700	$75,270,600	$32,784,750	**$594,678,915**
PFC					
PFC savings			$5,000	$30,000	
PFC opportunity			$27,878,000	$38,856,000	**$66,734,000**
Total					**$661,412,915**

Edge commentary will draw upon supporting evidence from References provided in the ESTS Consultation Paper as well as the University of New South Wales Centre for Energy and Environmental Markets report: "*Voltage Analysis of the LV Distribution Network in the Australian National Electricity Market*" dated May 2020, as commissioned by the Energy Security Board, which is chaired by Dr Kerry Schott (ESB Voltage Report)[1].

[1] https://www.dropbox.com/s/8rdvthjsg9ntats/ESB%20Report%20Voltage_Master_040520_Final.pdf?dl=0

Key Edge Recommendations

- **Edge recommends that the NSW government include Power Factor Correction and Voltage Regulation technology in the EST and Safeguard program**.
- **Both technologies support peak demand reduction while supporting reliability and sustainability of the electricity system.**
- **Both technologies deliver real, measurable reduction in consumption which translates into tangible financial benefits for customers.**

Section 1

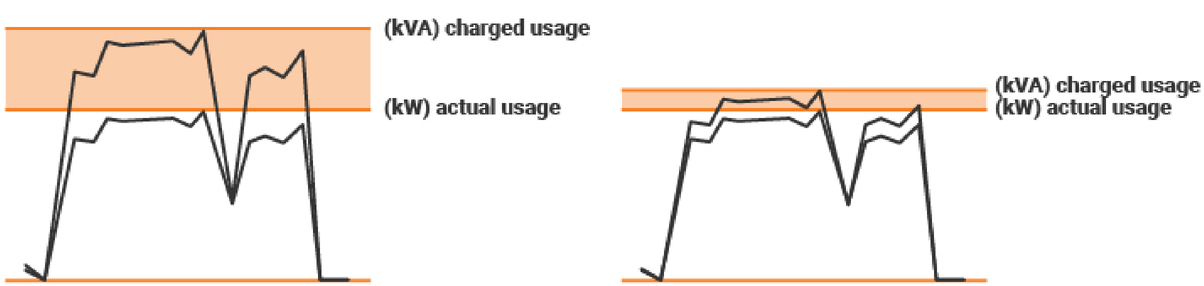
Proposed approach to Setting Energy Security Targets under ESSS (page 7)

The Consultation paper refers only to MW of energy generation and usage. This ignores the significant benefits available from assessment of total KVA demand and assessment of voltage and other power quality levels.

Edge recommends the following additions:

Use of PFC to reduce KVA demand:

PFC is an established energy savings technology used to reduce customer's peak demand charges. PFC reduces peak demand by supplying reactive power (kVAr) onsite and thereby lowering kVA usage. This frees up KVA generation capacity and KVA line capacity on the network system.
PFC reduces constraints on the LV network system which increases the scope for additional demand response activity:



Before PFC *After PFC*

Proposed approach of the EST focuses solely on MW of energy generation and usage. The Consultation paper references need to improve reliability and reduce usage of "network capacity", but does not reference kilovolt amperes (KVA), which is the key measure of Total Power, or network capacity (AER, 2014)[2].

Recommendation One: The ESSS should include provision for reduction of KVA and reactive power (KVAR) to achieve its stated goals.

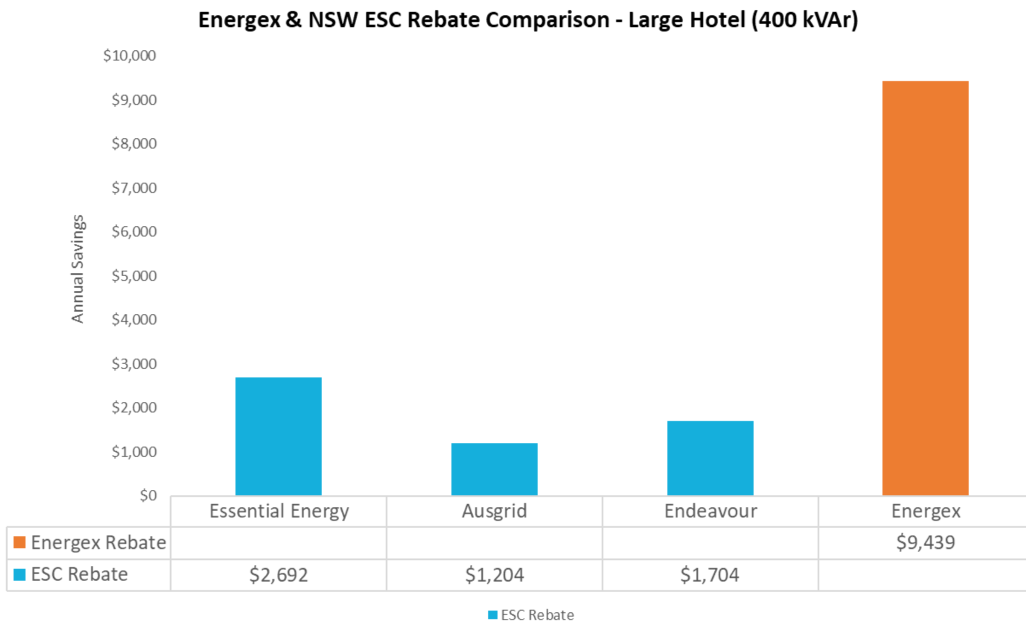
Reduction in KVAR will increase capacity utilization on the LV network. PFC reduces inefficient current flow, minimizes voltage drops and reduces the need to generate KVAR capacity. This delivers direct and measurable cost benefits to individual customers as well as system wide benefits in improved LV system capacity and reduction in CO_2 from the reduction in generation capacity needed to generate KVAR.

PFC technology is included in the existing NSW ESC program. However, the current level of ESC compensation is inadequate to promote the widespread adoption of PFC. This means a significant opportunity for peak power reduction and energy cost savings for customers is being missed

The graph below illustrates the significant difference in PFC rebates offered by NSW networks and Energex network in Queensland. The comparison is based on ACTUAL PFC savings and Energex rebate for the Sofitel Hotel in Brisbane, which has a 400kVAR power factor correction unit installed for the past 3 years.

It is clear that Queensland govt provides greater incentive than NSW for customers to improve Power factor and reduce energy costs.

[2] https://www.aer.gov.au/system/files/Ergon%20Energy%20-%202014%20Annual%20pricing%20proposal%20-%20Tariff%20implementation%20report%20%28Frontier%20Economics%29%20-%20Attachment%202%20-%2030%20April%202014.pdf



Energex has been supporting a highly successful PFC rebate program, ‘Positive Payback for business’[3]. This program has seen large scale adoption of PFC. Entire sectors within Energex, such as high schools[4], have been able to access lower electricity costs from the PFC installed thanks to this program. The success of this program was on account of a high Energex rebate offer of $41 per kVAr together with savings from avoiding high kVA tariffs.

The Energex rebate resulted in many customers being able to access energy savings opportunities based on the following SME and commercial payback thresholds referenced in the ESTS (which correspond to target returns for Edge customers).

Table 8 Payback thresholds for return on investment by market sector[22]

Market sector	Payback threshold (years)
Residential – low income	1.2
Residential – high income	2.2
Small to medium sized business	2.0
Commercial	3.2
Industrial	4.2

Department of Planning, Industry & Environment - Energy Security Target and Safeguard - Consultation paper

[3] https://www.energex.com.au/home/control-your-energy/positive-payback-program/positive-payback-for-business

[4] Edge data analysis of QLD clean energy schools program https://qed.qld.gov.au/programs-initiatives/det/building-education/major-projects-and-initiatives/advancing-clean-energy-schools-program

Why not let DNSPs raise KVA tariffs to drive PFC adoption?

The alternative of increasing KVA tariffs to drive greater PFC adoption may be economically unfair to certain customers, will take too long and is potentially punitive on smaller commercial customers with inadequate capital investment funds to purchase PFC or customers who lease their premises. PFC adoption needs to be accessible to commercial customers who rent as well as own their premises. Reducing payback on investment through inclusion in the ESS scheme is the best way to achieve this broader and fairer adoption.

The benefits of PFC are succinctly referenced in ***Energex Demand Management Plan 2019-2020, page 9***

"Customers on demand tariffs with good power factor have reduced demand costs. Power factor in alternating current (AC) circuits is the ratio of actual energy consumed (watts) versus the energy flowing through the wire (also known as apparent power). Power factor correction aims to reduce the difference between the energy consumed and the apparent power so as to reduce energy wastage and network losses. It can reduce the size of network assets required."

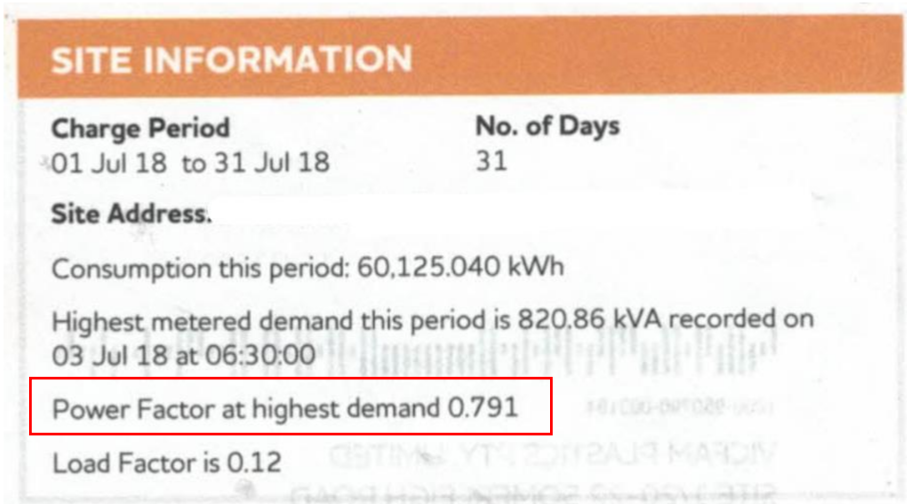
Availability: Proven PFC technology is currently available at commercial scale to meet demand created under the ESS. PFC activity and benefits can be included in the ESS scheme by 1 July 2021 at minimal administrative cost beyond an appropriate awareness and PR campaign through retailers and government.

The ESSS should make available a list of PFC suppliers is included in Appendix. Energex publishes a similar list of available PFC suppliers in Queensland.

Recommendation Two: There is minimal awareness of what PFC is and the extent of available savings. To achieve broader adoption of PFC a combination of customer awareness and financial incentive through broader inclusion in the ESS certificate program is required.

Networks and retailers should actively increase customer awareness of PFC alongside a supportive rebate program.

Most retail billing currently includes information on customer power factor. Retailers such as Origin, ERM and more provide data, but little or no explanation to customers:



SITE INFORMATION

Charge Period
01 Jul 18 to 31 Jul 18

No. of Days
31

Site Address.

Consumption this period: 60,125.040 kWh

Highest metered demand this period is 820.86 kVA recorded on 03 Jul 18 at 06:30:00

Power Factor at highest demand 0.791

Load Factor is 0.12

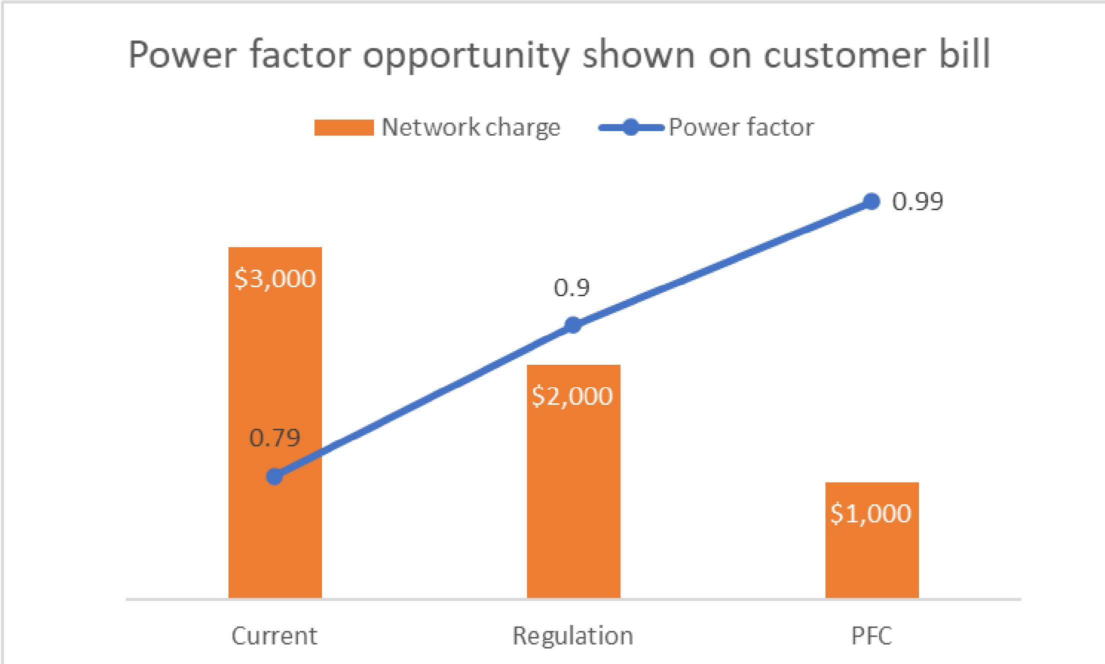
Customer bill showing power factor

Due to poor customer awareness, a power factor number alone does not assist a customer in any way. What is required is for this information to be translated into economic impact direct to the customer. Customers could be shown a comparison of what their current network charges are versus what they would be at the regulatory minimum of 0.90[5] and/or if the customer installed PFC to correct power factor to unity.

Customer bills may refer customer to ESS website or other source for information on how poor power factor causes excessive electricity costs and methods for reducing such costs, including ESS support.

An example is given below:

[5] Electricity Service and Installation Rules of NSW require that power factor for any site to be above 0.9 lagging https://www.ess.nsw.gov.au/Home/About-ESS/Energy-savings-calculation-methods/Power-Factor-Correction-Energy-Savings-Formula



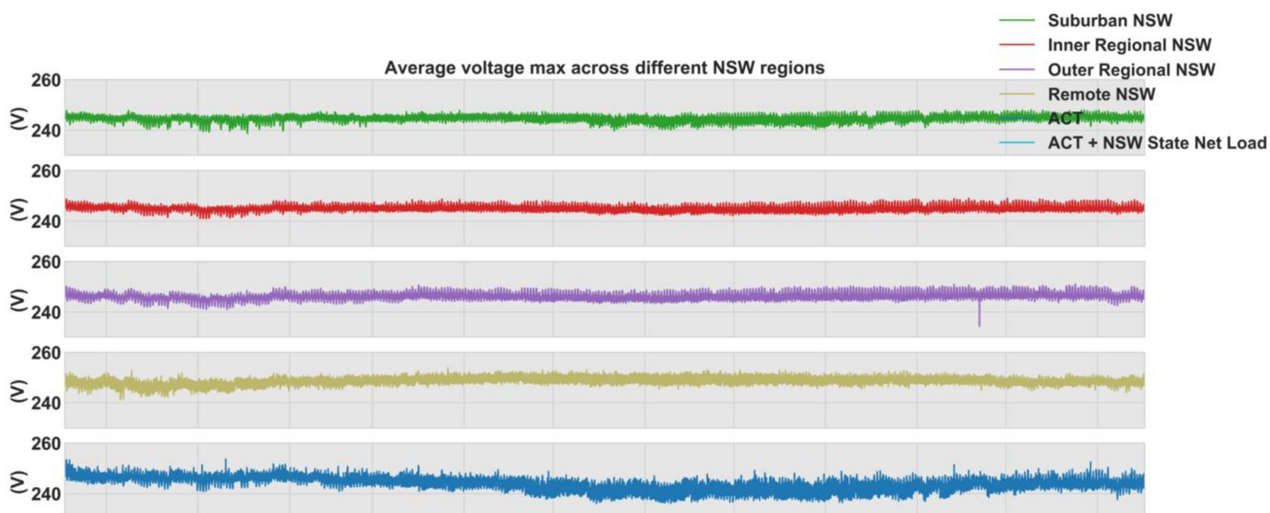
Recommendation Three: Customer bills should provide detail of a customer's current power factor. Bills should contain clear data on the $ savings available from improving power factor from existing to recommended 0.90 power factor

Use of Voltage Regulation (VR) to reduce energy usage and peak KW demand

DNSP voltages across the NEM are increasingly shown to be higher than the recommended range. High voltage results in higher KWH energy consumption, under generation or failure of residential solar systems and network unreliability, particularly in regional areas.

At present, the level of voltage compliance across the whole of Australia is difficult to assess given limited visibility of voltage conditions in the LV network. However, recent investigations continue to show that high voltage problems are increasing. A recent UNSW analysis of 1000 NSW sites since 2018 showed that around 85% of customers' PV sites experienced overvoltage at least once in 2018 and more than 25% of sites saw over-voltage on more than half of the days in the year[6].

An ongoing Energy Security Board analysis[7] shows that overall LV voltages are high and often near or above the regulated upper limit of 253V. This report cites extensively the impact of high voltage on increasing energy consumption and reducing output from residential solar systems, with reference to 4,381 residential sites across NSW.



ESB Voltage Analysis of the LV Distribution Network in the Australian National Electricity Market

Extensive global research has proven the relationship between increased voltage and increased KWH consumption, otherwise known as the **Conservation Voltage Regulation**

[6] Stringer, N., Bruce, A., & MacGill, I. (2017, December). Data driven exploration of voltage conditions in the Low Voltage network for sites with distributed solar PV. In Asia Pacific Solar Research Conference, Melbourne, Australia.

[7] ESB Voltage Analysis of the LV Distribution Network in the Australian National Electricity Market

or **CVR** This relationship varies according to different load types, however, international studies indicate an overall CVR range of 8% to 15%, which represents the equivalent reduction in KWH consumption for every % reduction in voltage.

US utilities widely practice CVR in order to reduce energy consumption, however it is relatively rare in Australia[8]. United Energy provided Demand Response using CVR as part of a recent ARENA trial, including provision of Demand Response to AEMO within the Reliability and Emergency Reserve Trader panel. More information on CVR research is provided in the appendix.

Results
Conservation Impact

Residential Customers

A 1.5% reduction in voltage is estimated to result in a 1.4% reduction in consumption

- Significant at the 1% level
- Implied CVR factor of .93 which is within range suggested by previous studies

Brattle Group found a residential CVR factor of 0.93 across 45,000 homes in PEPCO network.

Table 2
Summary of CVR studies.

Study	Year	CVR Factor
NEEA	2007	0.3–1.12
IPL	2013	0.7–0.8
NRECA	2014	0.8
West Penn	2013	0.86
Dominion	2012	0.92

Further Brattle Group reviews of previous CVR studies

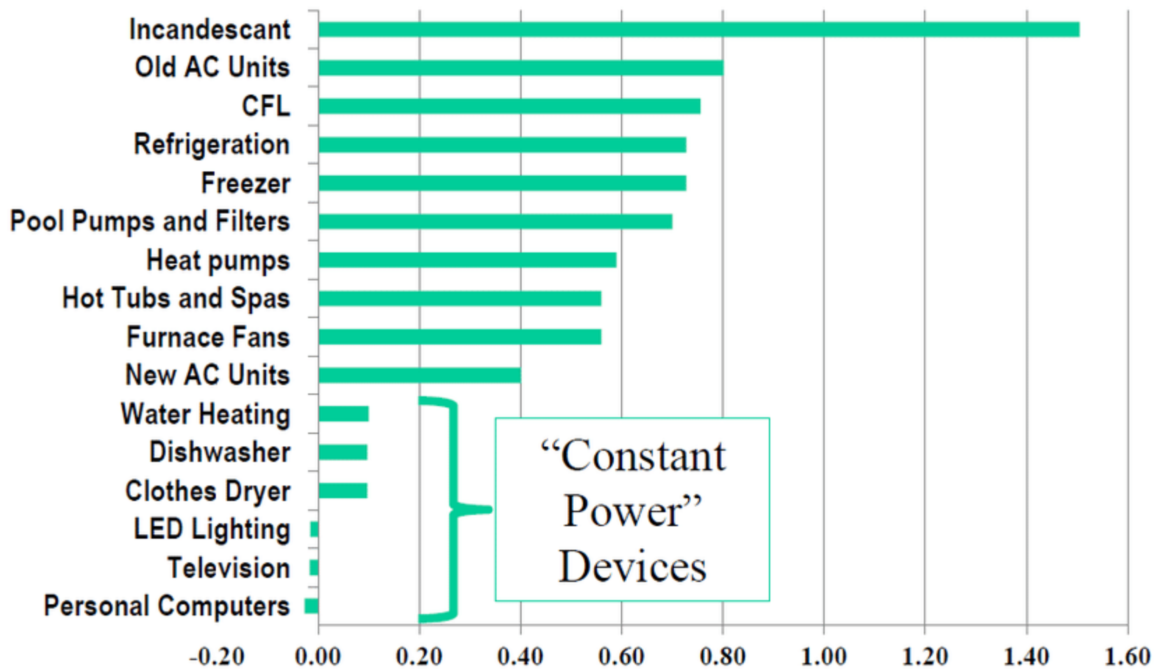
[8] ESB Voltage Analysis of the LV Distribution Network in the Australian National Electricity Market

Recommendation Four: In order to achieve its stated goals, Edge recommends the ESS should include benefits of voltage regulation in reducing peak demand and overall KWH consumption.

Voltage regulation will reduce overall KWH consumption. Cost benefits to customers and DNSPs from VR are measurable with a high degree of accuracy.

Voltage regulation delivers measurable peak shaving and peak demand reduction. The impact of VR on peak demand is greater owing to the increased sensitivity of peak, inductive loads (specifically air conditioners) to high voltage.

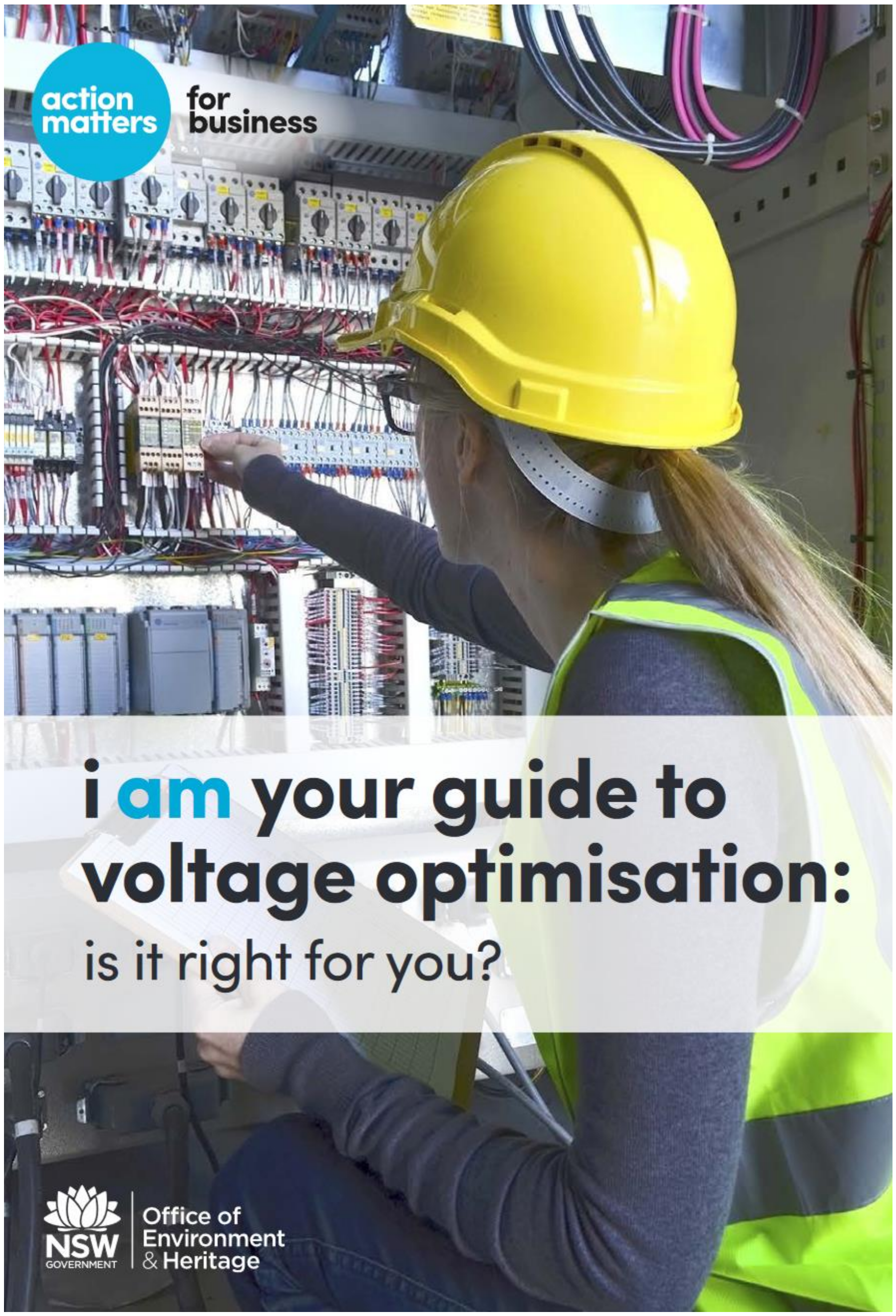
Examples of CVR factors for common residential appliances



Hayes, B., & Tomsovic, K. (2018, April). Conservation voltage reduction in secondary distribution networks with distributed generation and electric vehicle charging loads. In 2018 5th International Conference on Electric Power and Energy Conversion Systems (EPECS) (pp. 1-6). IEEE.[9]

9 https://www.researchgate.net/publication/327196596_Conservation_Voltage_Reduction_in_Secondary_Distribution_Networks_with_Distributed_Generation_and_Electric_Vehicle_Charging_Loads

Availability: Proven VR technology is available at commercial scale to meet demand created under the ESS from commercial and residential customers. VR activity and benefits can be included in the ESS scheme by 1 July 2021 at minimal cost.



NSW Government – Guide to voltage optimisation[10]

[10] https://www.environment.nsw.gov.au/resources/business/160226-voltage-optimisation-guide.pdf

Section 2

Should ESS targets use AEMO maximum demand forecasts?

KVA demand data and Voltage data forecasts

Current peak demand forecasts do not include KVA forecast. This is despite the fact that over 100,000 businesses in NSW are currently charged network demand tariffs based on peak KVA usage.

Maximum demand targets should be published in MVA and KVA, as well as MW and KW. These should be from AEMO, using TransGrid data. AEMO should be given access to corresponding demand data from DNSPs.

DNSPs should make available voltage data and power factor data to AEMO and IPART. *There is no additional cost to this service*. Voltage data is available from all commercial and smart meters. Power factor data is available from all commercially metered customers.

Recommendation Five:

EST should provide minimum of 3 years forecasts owing to fact that most commercial and residential investment thresholds are 3 years or less. These forecasts should be updated annually.

Should ESS certificates for VO be “deemed” or “project based”?

Edge recommends that any certificate scheme for VO is set up on a deemed basis. This is for the following reasons:

- Certificates based on **deemed abatement and benefit will have the greatest impact and success in delivering sustained peak demand management and efficiency**. This has been the experience with all Federal and State based certificate schemes to date.
- VO is independently measurable based on typical equipment types for residential and commercial customers. There is a substantial amount of national and international data to substantiate savings. Therefore a deemed methodology can be objectively supported;
- Deemed programs ensure more rapid uptake of technology and therefore more rapid rollout of energy saving and peak demand response technology.

The retrospective aspect of “project-based activity” has the following shortcomings:

- Delay in recognition and generation of certificates delays value recognition which reduces adoption rates.
- Retrospective assessment of peak demand events is difficult to assess owing to the fact that peak demand management activities, if successful, will have reduced the occurrence of such events.
- Peak demand events are by nature localized occurrences.
- Deemed activities are simpler and less expensive to manage.
- Real time monitoring will allow for validation of deemed activities over a 3-year period.

Recommendation Six:

Any certificate based assistance scheme must be administered and awarded on a deemed savings basis to have any positive effect.

Section 3

Provision and monitoring of information to customers (page 10)

Power factor data – any customer on a KVA network demand tariff should be given access to the following information on their bill:

i) Maximum demand during billing period, stated in kVA and kW;
ii) Minimum power factor during billing period, stated as fraction of 1.00, or Unity Power Factor;
iii) Potential reduction in KVA demand available from correction of existing power factor to Unity Power Factor (see ‘Power factor opportunity shown on customer bill, page 9
iv) Details of accredited providers of PFC solutions in appendix.

Voltage – premise level data from smart meters should provide information on maximum and minimum voltage levels for customers. There is currently very low awareness of the impacts of high voltage on solar performance and electricity consumption.

Under the ESS, customers should be made aware of the impact of current volt-var and volt-watt response modes, as well as AS4777 on performance of residential solar systems. These response modes can curtail solar production for 5-10% of the time for the majority of solar customers. For some customers voltage curtails solar and batteries for 100% of the time.

Customer energy monitoring - The Victorian VEU scheme includes energy monitoring as an eligible deemed activity for the creation of VEECs. Edge supports this activity for inclusion in the ESS on the following basis:

- International studies show energy monitoring drives proven energy savings activity, generating between 8-15% energy savings at a residential level[11];
- Energy monitoring technologies have developed significantly in recent years. However, the technology has received little support and promotion from energy retailers. In part this is due the inherent conflict in gentailers promoting less usage of their core product;
- Rollout of smart meters under the 'Power of Choice" legislation has been very poor. As a result, the majority of customers receive minimal data and advice on energy usage and energy reduction options and activities;
- Federal Government Customer data requirements encourage making energy data available to customers. However, the form of such energy data provision lacks definition and does not drive energy efficiency behaviour.
- ESS has the opportunity to provide customer focused energy monitoring services which drive genuine energy efficiency activity.
- See Appendix for industry recommendation on energy monitoring standards

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Recommendation Seven:

Driving further peak demand reduction through accurate energy monitoring and reporting is essential. Details of best practice energy monitoring standards are included in the appendix.

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[11] https://www.mckinsey.com/spcontent/connected_homes/pdf/mckinsey_connectedhome.pdf

Section 3

Extension of ESS to 2050 and increased ESS targets (see Q14-16; Q24-)

Edge supports the increase of targets to 13% by 2030. This target is achievable through the adoption of PFC and VR alone.

	Homes	Small Businesses	Medium Businesses	Large Businesses	Total
Employees	0	5-19	20-199	>200	
NSW Count	3,059,599	46,716	13,939	1,619	
Average Consumption	6 MWh	20 - 160 MWh	160 – 250 MWh	> 250 MWh	
Average Bill	$1,500	$25,000	$75,000	$250,000	
Voltage					
Voltage savings	$135	$2,250	$6,750	$22,500	
Voltage success	100%	70%	80%	90%	
Voltage opportunity	$413,045,865	$73,577,700	$75,270,600	$32,784,750	**$594,678,915**
PFC					
PFC savings			$5,000	$30,000	
kVA tariff			80%	100%	
PFC success			50%	80%	
PFC opportunity			$27,878,000	$38,856,000	**$66,734,000**
Total					**$661,412,915**

* *Calculation assumptions in the appendix*

The key barriers to more rapid adoption of PFC and VR technologies are:

1) Customer awareness – can be mitigated through inclusion in ESS and PR campaign;
2) Installation costs – can be mitigated by more coordinated roll out program, in particular VR technology at residential level. A program of multiple PFC and VR installation will enable significant scale reduction in installation costs.
3) Customer affordability – Edge does not support higher penalty rates which can add to overall customer cost. Key emphasis should be to ensure INCLUSION of all customers in benefits from PFC and VR. Consideration should be taken on following options:
    a. Means testing – low income customers have shorter ROI payback requirements on investment and potentially lower engagement. Consideration should be given to higher certificate generation for VR for low income households
    b. Tariff differentiation – certificate generation may be changed according to regional differences in KVA network demand tariffs.

Section 4

Cleaner fuels (page 21)

Edge believes that there is opportunity for improved efficiency and lower cost from fuel switching and new fuel technology, such as hydrogen and biomass. However, there are a number of existing Federal and other schemes which promote new technology to the point of commercialisation. The purpose of the ESS is to promote proven technology solutions which will deliver long term sustained customer savings for a broad-base of NSW consumers.

The ESS should operate under the following principles:

- Promotion of least cost energy savings technologies, taking into account long term supply cost inputs. In this case the *long term avoidance of demand* delivered by PFc and VO energy efficiency projects provides greater certainty in savings relative to dependence on market driven alternative fuel inputs;
- Promotion of established, proven energy saving and peak demand response technologies where ESS accelerates market adoption rather than "picking technology winners";
- Promotion of energy savings technologies which have the broadest application across the greatest proportion of customers. In this case solutions for system wide problems such as high voltage provides the greatest benefit to the greatest number of customers.

Section 5

Purpose and eligibility of peak demand reduction (page 25-32)

The value of peak demand response capability is a factor of the following:

a) Volume of power capacity reduced – what is the accuracy of forecast peak demand response mechanisms?
b) Timing of power reduction – what is the response time for peak demand reduction mechanisms?
c) Certainty of response mechanism – is the peak demand response mechanism firm or discretionary?
d) Customer data and information on demand response events

In each case, accurate customer energy monitoring is critical. In the absence of universal smart meter coverage, this monitoring must be provided by other means.

Section 6

Additional comments

Safety

There is increasing incidence of injury and fatality caused by broken return neutral wiring in LV distribution grids. The problem is caused by a combination of aging mains connections, overloading of the mains connection (including reverse power flows and operation of solar); poor wiring by soar installers.

Edge recommends that technologies supported by the DPIE of NSW should include broken neutral detection capability. It will save lives.

Impact of high voltage on solar operation

Under AS 4777 standards, volt-VAR and volt-watt response requirements, customer solar production is curtailed at high grid voltage levels. Based on data from ESB report, Edge estimates that over 15%of solar production is curtailed owing to high network voltages.

In addition, 5%of residential solar installations experience sustained zero output operation owing to high grid voltages.

Voltage regulation provides both reduction in customer usage as well as improvement in solar output.

Location based multipliers

The size of NSW electricity market results in varying supply constraints and value of energy savings and peak demand management activity by location.

The ESS should identify and reward energy saving and peak demand management activities by location. The current availability of independent consumption data, peak KVA demand data and voltage data by location allows for the targeted incentivization of VR and PFC technologies.

Liability for the ESS scheme

Electricity retailers are best positioned to manage liability for the scheme. Retailers have comprehensive data on individual consumption levels. They are also best positioned to identify customers for additional savings technologies.

Liability should allow for carry forward on a 3-year rolling basis. Annual liability may be affected by seasonal factors and/economic situation. Over a 3-year period this variability will work itself out.

Early expiry of certificates may increase cost to consumers

Appendix

PFC and voltage savings opportunity calculation assumptions

Power factor correction average savings uses an average for medium and large businesses across a range of kVA tariffs in Essential Energy, Ausgrid and Endeavour Energy.

Grid voltage	248
Optimised voltage	225
CVR	0.85

Home count:
https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/1

Business count:
https://www.industry.nsw.gov.au/__data/assets/pdf_file/0009/233487/Business-Size-Report.pdf

CVR Case Studies

Aged Care Facility		
	Before	**After**
Average Monthly Energy Usage (kWh)	24,174	21,938
Peak kW	75	66
Peak Current per Phase	99	87
Average Current per Phase	44	39
PF	0.98	0.99
Total Annual Bill	$ 72,503	$ 65,511
Total Annual Savings	$6,991.97	

Office building		
	Before	**After**
Average Monthly Energy Usage (kWh)	13,837	12,557
Peak kW	100	86
Peak Current per Phase	133	114
Average Current per Phase	57	50
PF	0.91	0.93

Total Annual Bill	$44,590	$39,436
Total Annual Savings	$5,153	

Energy monitoring best practice guide

The DER Visibility and Monitoring Best Practice Guide is now publicly available here: https://www.dermonitoring.guide/.

Thank you for your input, feedback and support, especially GreenSync, Wattwatchers, Enphase, Edge Electrons, Fronius, Redback, SwitchDin, ANU, Tesla, Sonnen, and SMA for all the time put in developing the Guide.

Energex PFC supplier list

Company	Contact by phone	Contact by email
AGL Energy Limited	0475 961 149 or 07 3023 2435	kwells2@agl.com.au
Atom Power	1300 922 883	seth@atompower.com.au
CAPTECH	0438 735 356 or 1300 280 010	jpiovesan@captech.com.au
Cole Contracting	0420 308 692	rob@colecontracting.com.au
Control Logic	1800 557 705	sales@control-logic.com.au
Culpans Electrical Contractors	0414 497 835 or 07 5535 3311	darylm@culpans.com.au
Darcy Electrical	07 5527 3400	admin@darcyelectrical.com.au
Downer Group	07 3249 0555	dep-qld-service@downergroup.com
Electrical Connexions	0417 516 298 or 07 3189 1754	sales@electricalconnexions.com.au
Energy Correction Options	0417 342 924 or 07 3268 0422	hfraser@ecoptions.com.au
Edge Electrons Limited	0412 544 362	patrick.slater@edgeelectrons.com
Energy Systems & Services Holdings Pty Ltd	0411 223 730 or 1300 001 377	chrisb@energyservices.com.au
EPC Technologies	0499 804 196	greg.denton@epctechnologies.com.au
ERM Power	07 3020 5115 or 0427 740 169	ldobrovolski@ermpower.com.au
Fredon	0413 805 190 or 07 3340 7300	astuart@fredon.com.au

Company	Contact by phone	Contact by email
Globalspec Pty Ltd	0402 084 563 or 07 5547 5569	globalspec@bigpond.com
High Technology Control Pty Ltd	0478 769 211	dave@hightech.com.au
NHP	07 3909 4999	cabbott@nhp.com.au
NuGreen Solutions	0407 934 166 or 1300 300 025	andrew@nugreen.com.au
Price Hilton Environmental	0419 413 434	vivirwin@pricehilton.com.au
Quality Energy	1800 736 374 or 0423 111 152	luke@qualityenergy.com.au
RENPRO Solutions	07 3200 1033 or 0433 362 602	brad@renprosolutions.com.au
Schneider- Electric	0418 646 181	ray.waite@schneider-electric.com
Statcom Solutions	07 3852 6886	sales@statcomsolutions.com.au
Sure Power	07 3249 3188	admin@surepower.com.au

Australian CVR studies

Wollongong Uni –1 transformer's voltage lowered 4.3% with savings of approx. 10% or $12,000/yr but needs further work to understand HVAC savings.

Sean Elphick, University of Wollongong Distribution Substation 8 Voltage Reduction Analysis Final Report, March 2015

Note: CVR study, not voltage optimisation, but shows clear evidence of savings

Wollongong Uni –Tech Note 13: cites an Australian study for Australian networks that reductions of 1% for real power and 2.3% for reactive power for every 1% voltage reduction.

Wollongong University Technical Note13 –Domestic Energy Saving Devices, June 2014

Note: CVR study, not voltage optimisation, but shows clear evidence of savings

United Energy Distribution Demand Response (ARENA)

$5.76m Funded by ARENA and $6.61m Total project cost

On December 2017, United Energy will use voltage control devices installed at substations across its entire distribution network to deliver demand response (DR) as a participant of the Demand Response initiative. The Project will deliver 12 MW of DR reserve from 1 December 2017, increasing to 30 MW of DR reserve in years 2 and 3.

The voltage will be reduced by an average of 3 per cent during peak demand surges, where appliances are able to continue being used. By only running the system at low voltages for short and controlled periods of time, United Energy can provide AEMO with reserve without harming their systems.

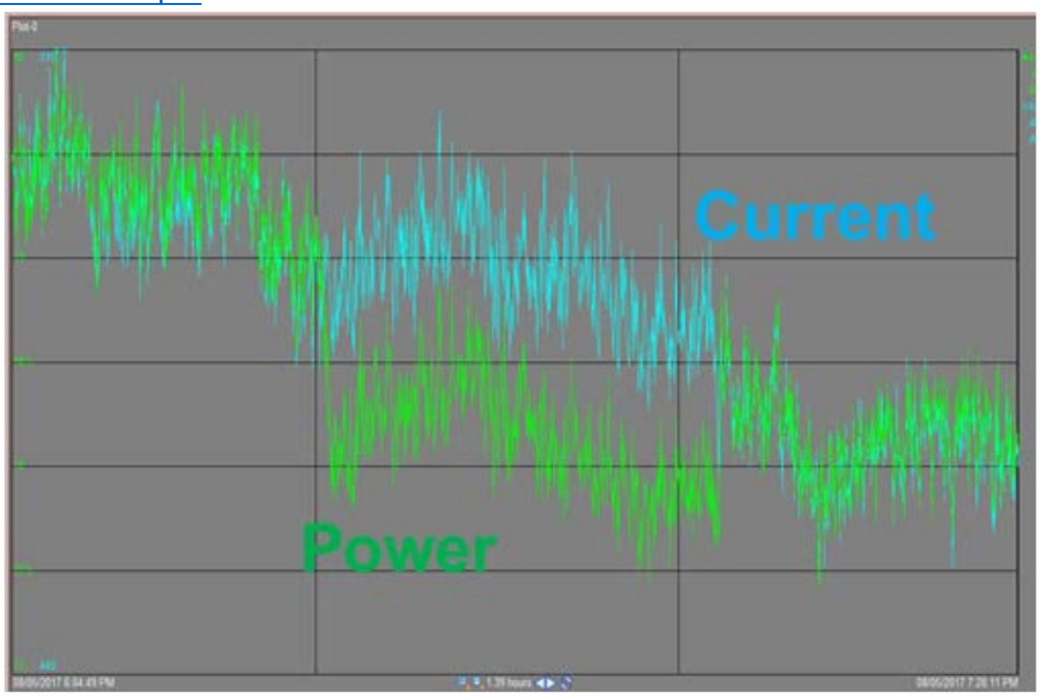
United have found a 0.8% real power reduction with a 1% change in voltage:

2. Overview of United Energy's Demand Response Service

United Energy intends to deliver the demand response services through the use of remote-controlled voltage reduction at our 47 zone substations initiated from our Network Control Centre. This service will use our existing fleet of smart meters deployed across the distribution network to provide time-lagged customer voltage data from all connected smart meters to enable reductions in voltage while maintaining voltage compliance during the demand response event. We intend to reduce the voltage across the network by 3% on average to deliver at least 30MW of demand response within 10 minutes when called upon, sustained over a 4 hour period between 10am and 10pm on business days. Due to the mathematical relationship between voltage and real power, as demand increases, the level of demand response provided by United Energy will also automatically increase.

Results of voltage reduction tests on the United Energy distribution network in 2017 reveal that there is a 0.8% real power reduction on average for every 1.0% voltage reduction and this can be sustained for a number of hours. This voltage reduction was implemented through the remote control adjustment of float voltage settings at our zone substations by our 24-7 manned Network Control Centre and can be implemented within 10 minutes of receiving instruction to reduce demand from AEMO.

https://arena.gov.au/assets/2018/08/united-energy-demand-response-project-performance-report-milestone-1.pdf



CVR of different appliances.

Singaravelan, A., & Kowsalya, M. (2017). A Practical Investigation on Conservation Voltage Reduction for its Efficiency with Electric Home Appliances. *Energy Procedia*, *117*, 724-730.

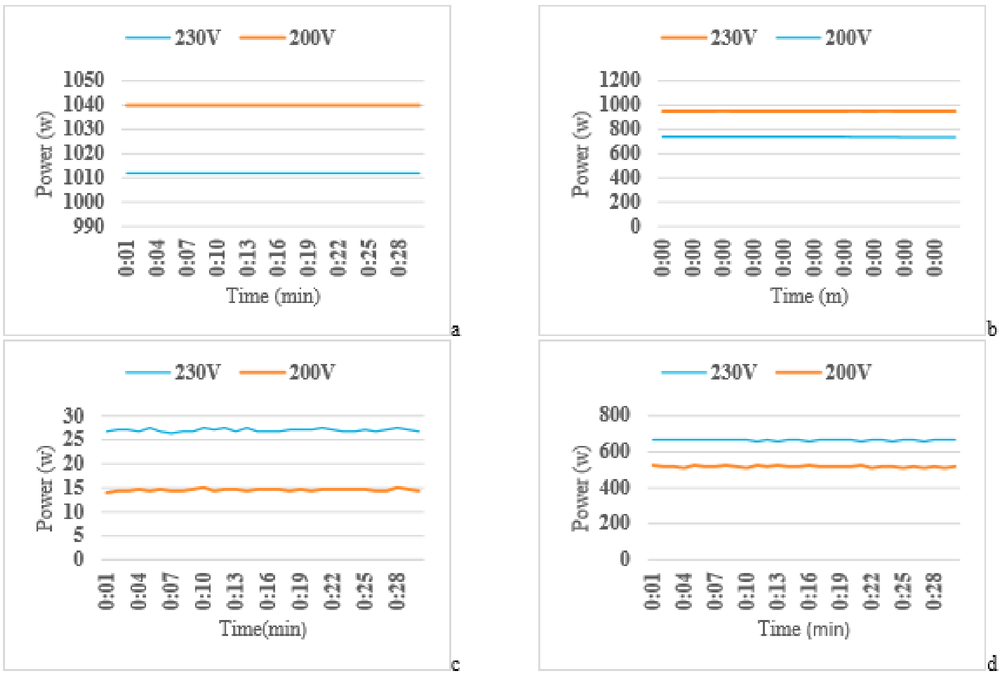


Fig. 2. Appliances Power Consumption, a. Induction Stove, b. Iron, c. Electric Cooker, d. Microwave oven.

A. Singaravelan et al. / Energy Procedia 117 (2017) 724–730

Table 1. Experiment result.

Appliances	Measured Power(Watt)		Percentage of power reduced (%)
	For 230V input	For 200V input	
Electric Cooker	609.45	467.13	23.4
Microwave Oven	666.10	526.60	20.9
PC desktop	55.00	55.00	0.0
Kittle	1840.00	1440.00	21.7
Iron	951.09	730.58	23.2
TV	121.83	121.83	0.0
Induction Stove	1012.00	1040.00	-2.8
PC monitor	17.00	17.00	0.0
Water Heater	1061.36	922.92	13.0
AC	800.00	635.16	20.6
Washing Machine	400.00	347.82	13.0
Fridge	109.00	94.78	13.0
Lighting	240.00	240.00	0.0
Table fan	30.60	22.85	25.3
Water pump	371.99	323.47	13.0
Mixer Grinder	296.23	238.00	19.7

5. Effects of Lower Voltage On Electrical Equipment

Lowering the voltage to electrical appliances and equipment is likely to result in energy savings but this will depend on the existing voltage levels and the type of electrical equipment used. Figure 4 provides guidance on the types of equipment that may benefit from voltage levels around the nominal voltage. A tick means the equipment's power consumption varies depending on the voltage supplied and a cross means the device is generally a constant power user regardless of the voltage being received.

Figure 4 – Effects of Voltage on Energy Consumption on Various Types of Equipment [1]

Equipment type	Energy/Voltage Sensitivity	Equipment type	Energy/Voltage Sensitivity
Incandescent lamps	✔	Motors: variable speed	?
Fluorescent lamps (inductive ballast)	✔	Refrigeration (uncontrolled)	✔
Fluorescent lamps (electronic ballast)	✘	Refrigeration (controlled)	?
Fluorescent lamps (high frequency)	✘	HVAC (flow controlled)	✔
High intensity discharge lamps (inductive ballast)	✔	HVAC (flow uncontrolled)	✘
Induction lamps	✘	Heating: coil/resistance	✘
LEDs	✘	IT equipment	✘
Motors: linear (fixed)	✔	Uninterruptable power supply (UPS)	✘
Motors: permanent magnet	✘	Equipment with inverters (surge protection)	✘

http://www.bccan.org.au/files/conservation_voltage_reduction_paper_v2.1.pdf

Page 16 onwards:
https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-19596.pdf