Review of submissions for new activities in the Victorian Energy Efficiency Target scheme - FINAL REPORT

transport | community | mining | industrial | food & beverage | carbon & energy



Prepared for:	**Department of Environment, Land, Water and Planning**
Client representative:	**Andrew Rothberg**
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Table of Contents

Prepared by: Douglas Ford, Tony Marker, Robert Foster, Steve Edwards & Lloyd Harrington.

Reviewed by: .... Date: 21 February 2016
Douglas Ford

Authorised by: .... Date: 21 February 2016
Steve Edwards

Revision History					
Rev No.	Description	Prepared by	Reviewed by	Authorised by	Date
00	Preliminary Findings	DF, TM, RF, & LH.	PH	PH	01/04/16
01	DRAFT Report	DF, TM, RF, SE & LH.	SE	PH	03/05/16
02	FINAL Report for Review	DF, TM, RF, SE & LH.	SE	PH	17/05/16
03	Changes from first review	DF, TM, RF, SE & LH.	DF	SE	15/06/16
04	Additional Changes	DF, SE.	DF	SE	21/02/16

Executive Summary

In December 2015, the Department of Economic Development, Jobs, Resources and Transport (the Department) called for submissions to create new activities for possible inclusion in the Victorian Energy Efficiency Target (VEET), resulting in 28 submissions. **pitt&sherry** has completed a review of 17 of these submissions, to assess their suitability for inclusion in VEET, in accordance with the requirements of the Victorian Energy Efficiency Target Act 2007 and associated regulations, and VEET Submission Guidelines.

The submissions were evaluated against criteria including; the extent of energy / emissions savings delivered by the activity over the "Business as usual" case, the "additionality" of including the activity in VEET (i.e. What is the benefit of including the activity in VEET compared with the case of not including it?), the level of dependence of the activity on user behavioural factors, the effects of location, OH&S issues, and the applicability of the different available abatement factor calculation methods.

None of the proposed activities were recommended for inclusion in VEET as a new method, although a number of activities are likely to be eligible for inclusion through the proposed new "technology neutral" project based methods that are currently under development.

The recommendations for each activity considered are summarised in the table below:

Proposed Activity	Reference Section	New Method Recommended?	Comment
Low Flow Tap Conversion	2.1	**NO**	Insufficient energy savings
Reflective Roof Paint	2.2	**NO**	Likely to be eligible for proposed new project based methods
Thermostatic Shower Valve	2.3	**NO**	Insufficient study data available to support savings estimate.
LED Lighting with extra functions	2.4	**NO**	Insufficient study data available to support savings estimate.
Power Factor Correction	2.5.1	**NO**	Insufficient effect on uptake
Voltage Optimisation	2.5.2	**NO**	• Insufficient study data available to support a new method. • Voltage Optimisation is eligible for lighting, under the existing Commercial Lighting Method. • Likely to be eligible for proposed new project based methods
Solar PV to Hot Water Diverter	2.6	**NO**	Insufficient data
Placebo Remote Control and Passive Occupancy Sensor for Air conditioners	2.7	**NO**	Insufficient data
In Home Displays	2.8 and 2.9	**NO**	Insufficient data available to support change
Plug-In Electric Heater Thermostat	2.10	**NO**	Insufficient study data available to support savings estimate
Hot Water Cylinder Temperature Controller	2.11	**NO**	Significant compliance burden exists
Assess Calculation for Standby Controllers	2.12	**NO**	Insufficient data available to support change
Gas Engine driven Reverse Cycle Air-Conditioning	2.13	**NO**	Insufficient testing data currently available for a deemed calculation method.

1. Introduction

In December 2015, the Department called for submissions to create new activities for possible inclusion in the Victorian Energy Efficiency Target (VEET), resulting in 16 submissions. **pitt&sherry** were commissioned to review these submissions and advise on their suitability for inclusion in VEET in accordance with the requirements of the Victorian Energy Efficiency Target Act 2007 and associated regulations and VEET Submission Guidelines.

The submissions were evaluated against the following criteria:

Energy / Emissions Saving over Stock Average: Each proposed activity was assessed for energy / emissions savings delivered compared with the average current performance of equivalent existing equipment currently installed. In many cases, specific performance studies are required to assess the variations in performance due to multiple factors. The availability of appropriate data on which to base an assessment was taken into account.

Energy / Emissions Saving over Business as Usual: In most cases, without any influence from VEET, the performance of energy consuming products and equipment is changing as new equipment replaces older equipment. This is driven by market demand and government regulatory changes. The savings delivered by proposed activities were assessed against the predicted future average performance of equipment, taking into account expected performance changes that will occur during the operating life of the activity.

Additionality: An important consideration in assessing activities for inclusion in VEET is to what extent inclusion in the scheme will influence take up of the activity. If the value of the VEECs[1] is very small compared to the cost of the activity, inclusion is likely to have little effect on take up. If the proposed activity is already cost effective and popular, inclusion in VEET may reduce the cost for users to implement the activity, but is not likely to increase the numbers of installations. Ideally inclusion in VEET will provide sufficient cost reduction to cause a significant number of users to implement energy efficiency measures that they would not otherwise have considered.

Dependence on Behavioural Factors: Behavioural factors can significantly influence the variation between different users of energy savings achieved by a proposed activity. Variations in savings can be accommodated in VEET "deemed" calculation methods if sufficient data is available to gauge the extent of the variation and justify the use of average performance or utilisation values. The sensitivity of each proposed activity to behavioural factors was evaluated along with the availability (or absence) of applicable study results that could be used to support the activity's energy savings estimate.

Potential Market Penetration: The scale of market penetration that might be achieved by the activity and the factors that would influence this were evaluated for each proposed activity.

Effects of Installation Location: The sensitivity of energy savings to factors such as climatic conditions and electricity supply emissions intensity, which vary from location to location within Victoria, were noted and incorporated into the recommended VEEC calculation methodologies.

OH&S Issues: Occupational health and safety (OH&S) risks to consumers and installers that may be associated with the activity and the control measures that may be required were noted.

Any Other Benefits: The objective of VEET is to deliver emissions savings, by assisting the implementation of energy efficiency measures. Other secondary benefits that may occur as a result of the activity are noted for reference.

[1] One "VEEC" or Victorian Energy Efficiency Certificate, is created for each tonne of Carbon dioxide (equivalent) emissions that is saved by the activity, over its assumed lifetime.

VEEC Calculation Method: Various options exist to calculate the VEECs generated by the proposed activity, depending on the variables which affect the energy savings. Recommendations were made for the most appropriate approach and the availability of the required data was evaluated. Where possible, calculation methods consistent with the approaches for existing activities were recommended.

The submissions considered are listed by activity area in Table 1 below.

Table 1 - Summary of Submissions.

Proponent	Proposed Activity	Reference Section
Aqualoc	Retrofitted flow restrictors for taps (not showers which are already included in VEET).	2.1
Thermoshield	Reflective roof paint	2.2
Embertek*	Thermostatic valve intended to save hot water wasted by shower users who do other things while waiting for the shower water to heat up.	2.3
General Innovation Australia	Replacement LED lighting incorporating additional features such as Blue Tooth speakers, WiFi repeaters and IP security cameras.	2.4
Edge Electrons*	Power Factor Correction and Voltage optimisation.	2.5
Energy Makeovers*	Power Factor Correction and Voltage optimisation.	2.5
Energy Australia*	Power Factor Correction and Voltage optimisation.	2.5
The Green Guys Group*	Power Factor Correction and Voltage optimisation.	2.5
Australian Wind and Solar	Device to divert solar PV panel generation to an electric resistance hot water cylinder.	2.6
Easy Warm	Device to divert solar PV panel generation to an electric resistance hot water cylinder.	2.6
Airconoff*	Placebo air conditioner remote control and retrofit passive occupancy controller for air conditioners.	2.7
Watts Clever	In Home Displays - Proposed amendment of existing abatement factors	2.8
Embertek*	Home Energy Gateway device - an In Home Display with communications abilities.	2.9
HeaterMate	Temperature controller to improve the efficiency of operating plug-in electric heaters	2.10
Solartek*	Retrofit hot water cylinder temperature controller with a legionella control function to reduce standing heat losses.	2.11
Embertek*	Assess calculation method for advanced IT standby power controllers for Schedule 29B.	2.12
Yanmar	Gas engine driven reverse cycle air-conditioning (instead of electric motor driven) to save emissions.	2.13

* Confidential submission, not published on Department website in part or in full

2. Assessment of Submissions

2.1 Aqualoc - Tap Flow Restrictors

Recommendation: This activity is not recommended for inclusion in VEET due to low additionality. The magnitude of the estimated lifetime emissions savings is insufficient for the monetary value of the VEECs to significantly influence uptake of the proposed activity.

Description of Activity: This submission proposes a new VEET activity, being installation of internal flow restrictors in water taps, with the intention of saving energy associated with the supply of both hot and cold water and hot water heating. The Aqualoc product is a valve insert that replaces conventional washers or 1/4 turn ceramic cartridges in spindle type taps, providing a flow control function and stopping leaks associated with worn out tap washers. Part of the Aqualoc design is patented.

This activity is similar to the existing VEET activities for replacing non-low flow shower roses, trigger nozzles and pre-rinse sprays with low flow equivalents. Like the existing methods the submission proposes that the savings would be based on replacing a non-low flow tap with flow restrictors rated at WELS[2] 3 Stars or better. Section 3.6 (Tap Equipment) of AS/NZS6400-2005 *Water efficient products - Rating and labelling*, provides a framework for rating the efficiency of taps that are for use over a basin, ablution trough, kitchen sink or laundry tub, but excludes taps that are solely for use over a bath. This reflects the likelihood that a tap will be used for "rinsing" for a period of time, where a lower flow rate is likely to lead to water savings, rather than delivering a required volume of water (such as filling a bath) where it will not. In residential dwellings the volume of water potentially saved by each installation, will be largest for bathroom basin taps.

The Aqualoc product is limited to spindle type taps. In residential dwellings, the popularity of this style of tap has waned in recent years in favour of mixer taps. Rather than limiting the activity to only cover installation of flow controllers in existing taps, it is proposed the activity be defined as replacing or upgrading a non-low flow tap with a WELS 3 Star or better tap or flow controller.

The activity should apply to pairs of hot and cold taps (where 2 taps discharge into a basin through one spout) or to single mixer tap installations. The activity should not include flow controllers installed on the end of a tap discharge spout (where the risk of the user uninstalling the controller is high). It should also be restricted to bathroom basin taps, and not include taps installed in kitchens, laundries or over baths.

Energy / Emissions Saving over Stock Average: While the maximum flow rates for WELS rated taps are defined under AS/NZS6400, the actual flow rates tend to be somewhat lower as users generally adjust the flow rate to suit their requirements. This means that water savings gained by installing a more efficient tap are less than simply the difference between the old and the new rated flow rates. Based on various studies, the report; *Evaluation of the Environmental Effects of the WELS Scheme*[3], suggests that an appropriate estimate for the operational flow rate for an "inefficient" bathroom tap is 3.3 l/min and for an "efficient" tap is 2 l/min. (An "inefficient " tap is taken to be rated at less than WELS 3 Stars and an "efficient" tap, WELS 3 Stars or over.) Published data on typical frequency and duration of use of taps for hand washing varies over a wide range. Based on the Green Star water consumption calculator[4], a frequency of 12 hand washing events per person per day, each with a duration of 9 seconds, has been selected for this estimate.

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[2] WELS is the *Water Efficiency Labeling and Standards* scheme, which is administered by the Australian Government Department of the Environment in partnership with state and territory governments. Its principal objective is to reduce water consumption by promoting the adoption of water saving technologies. WELLS star ratings provide information to consumers on the efficiency and water consumption of different devices. They are defined under AS/NZS6400-2005 *Water efficient products - Rating and labelling.*

[3] Fyfe, J., McKibbin, J., Mohr, S., Madden, B., Turner, A., Ege, C., 2015, Evaluation of the Environmental Effects of the WELS Scheme, report prepared for the Australian Commonwealth Government Department of the Environment by the Institute for Sustainable Futures, University of Technology, Sydney.

[4] Green Building Council Australia, *Potable Water Calculator Guide, Green Star - Office Design v3 & Green Star - Office As Built V3.*

The varying number of uses of hot water and cold water has been accounted for by assuming the average washing water temperature is 40°C.

This average usage compares well with other recent studies of actual hot water usage. Data from a Sustainability Victoria study[5] indicated an average use for the purposes of the calculation method of approximately 14 l/day of (58.5°C) hot water, for their small trial of 5 households averaging 3.5 persons. A South Australian Study of 12 houses[6] found an average daily use of 39 litres per person per day, and a study[7] of 5 Melbourne houses found an average daily use of 23.1 litres per person per day of hot water. Analysis of the Melbourne data showed that around 15% of total daily hot water use, or around 3.5 litres per day, was for hot water event sizes less than 5 litres. It is highly likely that hot water use for hand washing in the bathroom fits within this hot water event size range. This suggests that, if anything, our calculation of lifetime greenhouse saving from this activity, while small, might overestimate the abatement that can be achieved. The estimated lifetime emissions savings using these assumptions, plus other assumptions in line with the approach used to calculate the abatement factor for the existing VEET low-flow shower activity, is 0.17 tonnes of Carbon Dioxide equivalent (CO_2e). This is a comparatively small saving. The value of the VEECs resulting from this saving is unlikely to be sufficient to significantly influence the uptake of the proposed activity.

The details of the calculation are tabulated below:

Bathroom Tap - Heating Energy Saving Calculation		
Average people per household	2.41	
Average Uses per day per person	12	
Average Installations per household	1.45	
Average Uses per Week		
Percentage of Uses that are Rinsing Only		
Average existing flow rate	3.3	l/min
Average time of use - existing	9	sec
Average low-flow flow rate	2	l/min
Average time of use - low flow	9	sec
Average Cold Water Temp	14.5	°C
Average Use Temperature	40	°C
Life of Fitting	10	years
Discount factor for BAU	20%	
Volume Saved per installation	14,196	litres
Total Energy	1,210	MJ
Emissions savings split by water heater type		
Electric	0.11	t CO2e
Solar electric or heat pump	0.002	t CO2e
Natural Gas	0.055	t CO2e
LPG	0.001	t CO2e
Solar electric or heat pump	0.0002	t CO2e
Wood	0	t CO2e
Weighted Average Emissions Saving	**0.17**	**t CO2e**

[5] Sustainability Victoria, 2016 (June), *Gas Water Heater Retrofit Trial*

[6] Sustainable Energy Centre UniSA, *DMITRE Residential Water Heater Baseline Study,* 2014 (v1.0).

[7] E3, Commonwealth of Australia, April 2012*, Residential End Use Monitoring Program (REMP) – Water Heating Data Collection and Analysis*

Energy / Emissions Saving over Business as Usual: Currently a minimum WELS star rating for taps is not mandatory, but the WELS register of tap models indicates that very few taps with ratings below 3 Stars remain on the market and that numbers of 4 and 5 star rated tap models have steadily increased since WELS commenced in 2006. Stock turnover is an important indicator of the ability to make a change in the existing stock. The half life (~ the average lifetime of 50% of the stock in existence) is an indicator often used to describe how rapidly a change can be made. The authors of the WELS evaluation report based their stock turnover estimates on interviews with industry representatives and available data for similar products. In their modelling they assumed that the installed tap stock half-life was 13 years.

In line with the existing VEET low-flow shower calculation, a discount factor of 20% has been included in the emission saving estimate above, to allow for business as usual uptake of more efficient taps and the declining greenhouse intensity of water heating.

Additionality: As discussed above the existing stock of inefficient taps is steadily being upgraded over time with WELS 3, 4 or 5 Star rated taps as bathrooms and kitchens are refurbished. The likely value of the VEECs for this activity is insufficient to cause a significant change in the pace of tap upgrades.

Dependence on Behavioural Factors: The wide variation in frequency of use and user setting of flow rates has been discussed, and this is accounted for in the conservative average flow rates used to estimate the emissions savings.

Potential Market Penetration: Replacement of tapware is a strong ongoing activity, driven mostly by kitchen and bathroom renovations, wear and tear of older fittings and aesthetic trends. Fitting of low-flow controllers is a less expensive option, but more oriented to people interested in water saving and improving maintenance and reliability of their taps. The likely value of the VEECs for this activity is insufficient to cause a significant change in the pace of tap upgrades.

Effects of Installation Location: Energy savings relating to the supply of the water saved vary with the energy intensity of the system in different locations. Energy savings relating to saved hot water vary with climatic conditions and the type and efficiency of the hot water supply. Emissions intensity of electricity also varies regionally. While this application is not recommended for inclusion at this stage the above factors should be taken into account in any future deliberations.

OH&S Issues: There are no significant OH&S issues associated with this activity.

Any Other Benefits: This activity would have the additional benefits of reduced water and electricity costs to the owner of the premises.

VEEC Calculation Method: A deemed calculation method, consistent with the low flow shower head flow restrictor method would be appropriate for this activity, as described above. As for the existing Low-Flow Shower Head activity, regional factors relating to the emissions intensity of electricity would be applied.

2.2 Thermoshield - Reflective Roof Paint

Recommendation: This activity is not recommended for inclusion in VEET as a deemed method due to high variability between applications. This activity is likely to be eligible for the generic "technology neutral" project based methods that are currently under development.

Description of Activity:
This submission proposes a new VEET activity involving the application of a "Cool Roof Paint" (CRP) sold under the trade name "Thermoshield" to a pre-existing roof surface. The CRP typically has a significantly higher reflectivity and thermal emittance when compared with normal roof materials and coatings.

In warmer weather during periods of direct solar radiation CRPs maintain roof surfaces at a lower temperature than would otherwise be the case thereby reducing the amount of heat held and transferred to the building below. This can reduce cooling loads on space conditioning plant where installed or improve comfort conditions in buildings without cooling plant.

Energy / Emissions Saving over Stock Average:
The "stock average" roof surface can reasonably be assumed to be a roof surface with a lower reflectivity than the Thermoshield product (no data is provided in relation to the emissivity of the product). This will however vary from roof to roof. For pre-existing light coloured or bare metal roofs the difference will be less marked than darker coloured roofs.

Energy/Emissions savings compared to the stock average will be highly site dependent. Factors to consider include:

- The pre-existing roof reflectivity and emittance characteristics – the more reflective the pre-existing roof the lower the benefit in terms of cooling load reductions achieved
- The surface orientation of the roof and any overshadowing present – the less exposed the roof is to direct solar radiation the lower the benefit
- The local climate – the less cooling dominated the climate the lower the benefit. In fact in highly heating dominated climates the net benefit (heating and cooling) may be negligible or even negative[8]
- The nature of the building fabric and in particular the level of ceiling (or roof) insulation installed – the more highly insulated the ceiling the less effective the activity will be in reducing cooling loads
- The presence of cooling equipment – Savings in energy can only be realised if the building includes cooling plant. For example, a warehouse with highly exposed metal roofing and little insulation may benefit from this activity in terms of the comfort level of occupants in the summer but no energy will be saved as typically no cooling plant is installed. On a cold but sunny winters day the activity is likely to reduce heat gains into the building and increase the need for radiant heating (which is often provided for staff in these types of stores)[9]
- The internal heat loads within the building (i.e. what type of heat producing activity is undertaken within the building) – this can greatly impact on heat loads and the potential benefits associated with the activity
- The occupancy profile of the building – low occupancy during times of peak cooling load would reduce the benefits associated with this activity

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[8] Australian Building Codes Board (ABCB) 2013 - Independent review of the thermal performance of roofing materials.

[9] Note: In some of the material provided there is a claim that this activity can also reduce heat loss in cooler conditions. This may be the case under some conditions but is unlikely to be the case on clear winter days where solar radiation will raise the surface temperature of a darker roof compared to the CRP treated roof. The data provided in relation to this aspect in the report "A field test to measure the effect of cool roof paint on a six star residential building (DSE 2012) is very limited, focusing only on a single day in May at the start of winter with no indication of the degree of solar radiation received on that day (a subsequent check of BOM records indicates a below average level of solar radiation on that day of 5.9 MJ/m²). This report acknowledges this limitation (in terms of winter performance assessment) and notes "The study does not accurately cover a complete year due to timing of the monitoring, although the monitoring will continue and future reporting will account for this limitation" – no such future reporting has been found.

- The degree of dirt/pollution likely to be deposited on the CRP surface - polluted atmospheric conditions will reduce the efficacy of the surface coating and thereby reduce potential benefits.

As noted above, any savings will be highly site specific and as such this activity in many cases will be best suited to the proposed Measurement and Verification method that is currently under development.

Energy / Emissions Saving over Business as Usual:
Business as usual can reasonably be assumed to be the same as the "stock average" – see discussion above.

Additionality:
The background level of uptake of this activity is expected to be relatively low (partially due to the relatively high cost). An additionality of at least 90% could be expected.

Dependence on Behavioural Factors:
The effectiveness of the activity is largely unaffected by behavioural factors, except as follows:

- In highly polluted areas the effectiveness of the coating will be compromised as grime builds up on the surface. In these circumstances regular cleaning would be required to ensure consistency of savings over the life of the product.

Potential Market Penetration:
All buildings have roofs; consequently this activity could in theory be applied to almost every building found in Victoria. The cost of the activity is likely to be the main limiting factor in terms of market penetration. Consequently the penetration would be expected to be low unless a significant financial incentive was to be offered. A[10] far cheaper option would be to add additional ceiling insulation (where practical) rather than applying CRP.

Effects of Installation Location:
As noted above, the effectiveness of the activity will depend in part on the geographical location. The activity can be expected to provide the highest level of benefit in the north of the state which has significantly higher summer temperatures and higher levels of direct solar radiation than the remainder of the state.

OH&S Issues:
The activity would need to be undertaken by contractors with appropriate working at heights training, appropriate health & safety tickets & experienced in coatings applications. Breathing apparatus may also be required.

Any Other Benefits:
Other benefits could include:

- Reductions in peak electrical load and cooling plant capacity requirements
- Improved thermal comfort conditions in situations where no cooling plant is installed (e.g. the "Bunnings" example noted above)
- Improved health outcomes for occupants where heat stress is likely to occur (again this typically relates to situations where no cooling plant is installed)
- Extension to the life of the roofing material – resulting in saved resources otherwise required to replace the roof at the end of its life.

VEEC Calculation Method:
As noted above, the potential savings are highly dependent on the application site. As a result it would be difficult to ascribe a single deemed value to this activity.

[10] Australian Building Codes Board (ABCB) 2013 - Independent review of the thermal performance of roofing materials.

For residential buildings a deemed benefit for a stock average dwelling type may be possible to determine but it is expected that the activity is only likely to be viable in the hotter north of the state. Limited thermal simulation analysis suggests that the activity is unlikely to have a net benefit to housing in the southern part of the state.

For non-residential buildings the application of a deemed value is problematic due to the diversity of factors noted earlier in this report. Where the parameters of the application are more certain (e.g. a data centre where there is a predictable cooling load profile) a deemed value may be possible to ascribe (possibly with differing values by climate zone). But for many other non-residential building types a Measurement and Verification based type calculation method may be the only viable option.

2.3 Embertek- Thermostatic Shower Shut-Off Valve

Recommendation: This activity is not recommended for inclusion in VEET due to a very high dependence on and the absence of local shower behaviour data.

Description of Activity: The submission proposes a new VEET activity involving the installation of a thermostatic water shut-off valve between the shower arm and the shower head, which senses the water temperature at the shower head, and shuts down when bathing temperature is reached, reducing water flow to a trickle. The user manually opens the valve when ready to bathe. This allows cold water to be purged from pipes in the normal way, but prevents waste of water and energy after bathing temperature is reached if the user is delayed by other activities (e.g. toilet, brushing teeth, etc.) before actually entering the shower.

Energy / Emissions Saving over Stock Average: The proponent has estimated savings of around 1,400MJ/year, based on a US study of shower usage in a number of houses which suggests an appreciable delay between the shower water reaching bather temperature and the average user entering the shower. Based on VEET Schedule 17 and the US study timing data, the submission estimates VEECs of 1.7 (metro) and 3.8 (regional).

Energy / Emissions Saving over Business as Usual: No other devices specifically aimed at reducing this aspect of hot water waste are known to be on the market. The savings will be reduced over time by the ongoing uptake of shower heads with lower flow rates.

Additionality: Inclusion of this activity in VEET is likely to greatly assist the marketing and awareness-raising of this device and its possible savings with householders, which is likely to lead to its greater uptake.

Dependence on Behavioural Factors: The device causes no change to the actual shower process other than that the user is required to open the valve with a simple pull on a tag/ lever attached to the valve to reinstate full flow. The user could remove the device (with the same effort as would be required to install a new shower head) but would not be able to by-pass the shut-off valve without uninstalling it.

The potential savings generated by this activity are made by addressing waste generated by shower user behaviour. The submission assumes that the US study cited is representative of Australian shower users' behaviour. No similar Victorian (or Australian) studies were able to be found. Evaluations of the WELS programme and numerous other water saving programmes that have been, and continue to be conducted in Victoria and Australia in general show a high degree of awareness of water saving amongst the general public. These studies show that campaigns carried out in times of drought have resulted in behaviour changes which reduce both outdoor and indoor water consumption. These behaviour changes have remained relatively well entrenched, even after drought has receded and water restrictions have been lifted. Under these circumstances it is unlikely that US data on shower usage will be accurate for the Victorian context. To substantiate the potential water savings that might be expected from this activity, local studies would be required.

Potential Market Penetration: In principle the shut-off valve is applicable to all showers and could have a very large uptake. However, it may be difficult to convince the public of the shut-off valve's benefits and gain acceptance of the requirement to re-open the valve at the start of each shower.

Effects of Installation Location: Energy savings relating to the supply of the water saved vary with the energy intensity of the system in different locations. Energy savings from reduced hot water use vary with climatic conditions and the type and efficiency of the hot water supply. Emissions intensity of electricity also varies regionally. These factors would need to be taken into account in any future calculation method.

OH&S Issues: None. Installation is simple and would be carried out by a qualified plumber.

Any Other Benefits: Water and cost savings to the householder.

VEEC Calculation Method: A deemed calculation method would be appropriate for this activity. The calculation method would be similar to the low-flow shower head activity. An independent local study of shower user behaviour would be required to substantiate the volume of hot water saved.

2.4 General Innovation Australia - LED Lighting with Additional Features

Recommendation: This activity is not recommended for inclusion in VEET, due to insufficient data on which to base an estimate of the energy savings.

Description of Activity: The proponent markets a range of LED down lights that incorporate additional devices within the light housings, such as blue tooth speakers, WiFi repeaters and IP security cameras. Installation of augmented LED lamps, to replace an existing halogen lights and an existing additional external device, is proposed in the submission as a new activity in VEET.

A significant energy saving is achieved where halogen down lights are replaced by LED lights, which is an existing activity under VEET. The submission also suggests that additional energy savings can be made where the additional features replace older, stand alone equivalent equipment. For example it is suggested that the blue tooth speakers use less energy than a conventional stereo. While it is certain to be the case that the additional features consume less energy than many specific examples of equivalent standalone equipment, the extremely wide range of consumer devices available on the market, and the constant change in models and specifications and the ways they are used, makes it extremely difficult to assign a typical representative value to the energy saved.

Energy / Emissions Saving over Stock Average: There is a high level of variability and insufficient data to quantify non-lighting energy savings with sufficient confidence to create a new method for this activity under VEET.

Energy / Emissions Saving over Business as Usual: The non-lighting energy savings are difficult to quantify with sufficient confidence and are likely to change rapidly as different alternative products come to market.

Additionality: The additional consumer uptake of these lamps that would result from inclusion of the proposed activity in VEET is difficult to quantify, but it is likely that it would have a minimal impact, unless the monetary value of the VEECs were sufficient to provide a large cost reduction.

Dependence on Behavioural Factors: The energy savings from the additional features would be highly dependent on user behaviour, which could reasonably be expected to vary widely. The life before the feature became redundant or was superseded will also vary widely and is unlikely to be long for this type of product.

Potential Market Penetration: Likely to be low. Most consumers are arguably likely to make purchasing decisions to buy lights separately from other products.

Effects of Installation Location: There are no significant effects from installation location.

OH&S Issues: There are no significant OH&S issues associated with this activity.

Any Other Benefits: None.

VEEC Calculation Method: While this method is not currently proposed it is noted that a deemed method of savings calculations may be suitable in the future, if sufficient data was available.

2.5 Energy Makeovers, Energy Australia, The Green Guys Group and Edge Electrons - Power Factor Correction and Voltage Optimisation

Description of Activity: Energy Australia, The Green Guys Group, Energy Makeovers and Edge Electrons all made similar submissions supporting the creation of new methods to allow inclusion in VEET of power factor correction (PFC) and voltage optimisation activities. PFC and voltage optimisation each require different equipment to implement. The energy savings opportunities for each activity vary widely, independently of each other. For these reasons the activities have been evaluated separately.

2.5.1 Power Factor Correction

Recommendation: This activity is <u>not recommended for inclusion in VEET</u>. There is an existing change in the billing system underway which has the potential to increase uptake of these devices. In certain size classes and regions the economic case for installation is already strong. In metropolitan areas VEET has little effect. However in some other size classes VEET may have a role in stimulating uptake. It is recommended that the changes to the tariff system and the uptake of the devices be monitored, and to consider the measure when trends are more certain. In the case of possible uptake the calculation method is suggested below.

Description of Activity: PFC is a well established means of reducing losses in the electricity distribution network. Low power factors result in additional current being required to deliver the same amount of energy, resulting in higher resistance losses in the power lines. The poor power factor is typically caused by inductive loads like electric motors. This effect can be reduced by adding capacitors. Capacitors are used as the basis of commercially available PFC devices.

Commercial and industrial electricity tariffs are now billed for the current drawn (kVA) as well as the energy used (kWh), so installation of a PFC device reduces a user's bill and reduces the losses from the grid. The greenhouse gas and energy savings occur as a result of these reduced losses in the electricity grid. In most cases the energy savings at the user's site are negligible.

PFC has been recognised as an activity under the New South Wales Energy Saving Scheme (ESS) and a deemed energy savings method has been created. The NSW method applies to any electricity connections, at a voltage less than 50kV, that improve the power factor above a minimum of 0.9. To be eligible they must not be installed as part of a mandatory programme or a legal requirement to provide PFC. The energy savings calculation method is based on the improvement above 0.9 provided after installation of the PFC device, up to a maximum of 0.98. The NSW method also restricts the energy savings calculation to 1750 hours of operation per year. This is on the basis of a combination of US, European and Australian studies of average full time equivalent hours for electric motors in industry[11]. The objective was to simplify the data recording / validating function in the application of the measure.

The factor of 0.9 as the minimum cut-off for PFC should be altered to equivalent Victorian values (see discussion below about the difference between the NSW and Victorian requirements). The time of application limit of 1750 hours could be removed from the equations and determined during the PFC baseline testing or from authority records.

[11] Advice from Office of Environment and Heritage regarding the origin of the figure.

However it is noted, as for the decision for the NSW method, that this increases compliance costs. The discussion and analysis below examines these possibilities and indicates that increased compliance costs may be a significant detriment to the measure.

Energy / Emissions Saving over Stock Average: There are likely to be a moderate number of medium to large users that could achieve power factor improvements above what they are obliged to do under the electrical connection regulations.

Energy / Emissions Saving over Business as Usual: Changes in technology, including the increased use of variable speed drives are likely to improve power factor under the business as usual case. For all states there are rules that govern the acceptable power factor for any site. For instance the Electricity Service and Installation Rules of NSW require that power factor for any site to be above 0.9 lagging[12]. For sites with extremely poor power factors the installation will be self-evident on economic grounds. The NSW ESS method for PFC does not credit improvement of power factor from less than the 0.9 to a maximum of 0.98 as supported in the below calculation method. This accounts for business as usual uptake.

The situation for Victoria is different, especially for smaller customers. Allowance for additionality here requires the use of factors other than 0.9 which can be varied according to the following Table 2. The upper factor of 0.98 still applies as in the NSW calculation.

Table 2: Power Factor limits for Victoria[13]

POWER FACTOR LIMITS						
Supply Voltage in kV	Power Factor Range for Customer Maximum Demand and Voltage					
	Up to 100 kVA		Between 100 kVA - 2 MVA		Over 2 MVA	
	Minimum Lagging	Minimum Leading	Minimum Lagging	Minimum Leading	Minimum Lagging	Minimum Leading
< 6.6	0.75	0.8	0.8	0.8	0.85	0.85
6.6 11 22	0.8	0.8	0.85	0.85	0.9	0.9
66	0.85	0.85	0.9	0.9	0.95	0.98

[12] ESS scheme background information.

[13] Victorian Electricity Distribution Code December 2015, Version 9.

Additionality: PFC units are currently installed, primarily by larger electricity users, to ensure compliance with minimum power factor regulations and reduce electricity costs. Where significant other deemed activities have been undertaken which have a side-effect of reducing power factor these should be conducted first, before the measurement of site power factor in this calculation.

Commercial / Industrial users are either on, or will soon be required to be on, kVA tariffs. Hence they either have already or will shortly have a financial incentive to pursue power factor correction. Hence there is reasonable logic in using the regulated requirement for power factor as the lower bound for calculating the value of the VEECs. Domestic users are on real power (kWh) tariffs, so there is no existing incentive for PFC. Even if they were on kVA tariffs, their usage of particular items of equipment is sporadic and the economics of PFC is poor. This is in part due to the intermittent nature of use of individual devices in the home, and in part due to the fact that individual household devices have a large range of power factors.

The additionality created by adding this activity to VEET, would be to make it financially attractive to install PFC to a greater extent, including for smaller users. We have examined this likelihood of altering existing market behaviour, for several different scenarios, in Table 3 below.

Table 3 compares the value of the VEECs with the value of the PFC installation equipment. The calculation method for the VEECs is shown in the following sections. There is a distinct economy of scale in the capital cost of PFC units. For this reason we have examined a modest sized unit (100kW real power) and a much larger unit (700kW real power) at different combinations of rules and usage. We have compared what would occur if the NSW rules (described below) were applied. For calculation of the project payback from the project owner's perspective we have used a demand charge of $15/kVA/month (this is an approximate maximum – depending on tariff chosen - based on the demand charges in 2016 tariffs of power companies listed in Table 4). The method for estimating the energy / emissions savings is explained in the "VEEC Calculation Method" section later in this report.

The different scenarios considered are as follows:

Moderate usage scenarios (Columns 1 to 6) display results for a typical power factor from 0.85 to 0.97 average, including:

- Time restrictions applied according to the NSW rules in Column 1 and
- Time and power factor restrictions applied according to the NSW rules in Column 2.

These restrictions produce a VEEC value of less than 5% of project costs and of a very low absolute dollar value such that no industrial user would attempt a verification method requiring performance measurement as the time spent outweighs the benefit.

The scenario presented in Column 3 assumes unrestricted hours and a power factor within the range according to the proposed VEET rules. This scenario shows a plausible benefit of 22% of project costs and an absolute value of about $3400. This is a value that would justify a project using data collected from an authority meter, but not is unlikely to be sufficient to fund prolonged external testing.

The scenario presented in Columns 4-6 assume restricted operating hours (but not restricted power factors) for other combinations of supply voltage and district (per Table 5).
This confirms that for other combinations within Victoria the impact of the VEECs on the project economics is minor.

The simple payback calculation for all these scenarios lies between 4.7 and 6 years.

The lower relative capital cost of <u>larger units</u> is explored in Columns 7-9. The three scenarios are:

- Column 7 which is unrestricted by time limits or power factor (within this range according to the proposed rules)
- Column 8 with limiting operating times according to the NSW rules, and
- Column 9 with the lowest grid distribution loss factor (DLF) scenario (which is for a high voltage grid connection in a metropolitan area).

These show that the relative effect of the VEEC is much larger for the unrestricted scenarios where VEECs contribute 71% of project cost. However the original project payback (without a contribution from VEECs) is already compelling at 1.5 years.

We conclude that:

- Only in the case of the unrestricted calculation would the VEEC be of benefit
- In the case of smaller PFC units consistent with domestic use (i.e. with lower capacities than those considered in Table 3) the VEEC cannot assist as the economic case is already poor and the VEEC value too low to significantly improve it
- In the case of larger PFC units, the economic case is already compelling
- In metropolitan areas, PFC does not produce significant emissions savings due to the low network Distribution Loss Factor (DLF) and
- VEET would have a very limited role specific to PFC units of between 100 and 300kW real power and power factors of around 0.85 or higher (delivering simple paybacks of 2.7 to 4 years) in rural areas, in situations of relatively continuous usage. Lower initial power factors in this sector produce shorter paybacks (e.g. 1.5 year for a 300kW unit at initial power factor of 0.75, without a VEEC contribution). This small window of influence diminishes any potential effect of VEECs on uptake.

Table 3: Multiple scenarios for VEET treatment of Power Factor Correction. See text for discussion.

Note: Column 2 uses 0.85 PF for owner savings and installed capacitance but 0.9 PF for VEECs.

	LV	LV	LV	LV	HV	HV	LV	LV	HV		Reference
	1	2	3	4	5	6	7	8	9		
scenario	regional limited hours	regional limited hours limited PF	regional actual continuous	metro limited hours	regional limited hours	metro limited hours	regional actual continuous	regional actual continuous	regional actual continuous		
PF existing	0.85	0.90	0.85	0.85	0.85	0.85	0.75	0.75	0.85		
PF corrected	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97		
total kW (real power)	100	100	100	100	100	100	300	300	300	kW	*moderate / high scenarios*
charge rate	$ 15.00	$ 15.00	$ 15.00	$ 15.00	$ 15.00	$ 15.00	$ 15.00	$ 15.00	$ 15.00	$/month/kVA	
district	regional	regional	regional	metro	regional	metro	regional	regional	metro	MJ	
supply voltage	240V / 415V	240V / 415V	240V / 415V	240V / 415V	11kV / 22kV	11kV / 22kV	240V / 415V	240V / 415V	11kV / 22kV		
distribution loss factor (DLF)	1.10	1.10	1.10	1.04	1.07	1.01	1.10	1.10	1.04		*as per Table 4, this report*
minimum capacitance	36.9	36.9	36.9	36.9	36.9	36.9	189.4	189.4	110.7	kVAR	*calculated from PF*
installed capacitors	55.4	55.4	55.4	55.4	55.4	55.4	284.1	284.1	166.1	kVAR	*1.5* allowance for peaks*
daily operating hours	8	8	24	8	8	8	24	8	24	hours	
days per week	5	5	7	5	5	5	7	5	7	days	
weeks	43.75	43.75	52	43.75	43.75	43.75	52	43.75	52		
yearly operating hours	1750	1750	8736	1750	1750	1750	8736	1750	8736	hours	
site lifetime	10	10	10	10	10	10	10	10	10	years	*suitable for this equipment*
Calculate average power saving											
power saving	1.41	0.76	1.41	0.43	0.92	-	7.34	7.34	1.30	kW	
Lifetime Energy Saving	24,656	13,264	123,081	7,595	16,125	-	641,014	128,408	113,741	kWh	
	88,760	47,749	443,091	27,342	58,051	-	2,307,649	462,269	409,469	MJ	
Victorian Electricity Emissions Intensity	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	kgCO2e/MJ	
Emissions Saving	**27.0**	**14.5**	**134.7**	**8.3**	**17.6**	**-**	**701.5**	**140.5**	**124.5**	**t CO2e**	
VEEC Price	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25	$ 25		
Total value of VEECs	$ 675	$ 363	$ 3,367	$ 208	$ 441	$ -	$ 17,538	$ 3,513	$ 3,112		
PFC unit supply price	$ 12,000	$ 12,000	$ 12,000	$ 12,000	$ 12,000	$ 12,000	$ 19,000	$ 19,000	$ 19,000		
installation price	$ 3,600	$ 3,600	$ 3,600	$ 3,600	$ 3,600	$ 3,600	$ 5,700	$ 5,700	$ 5,700		
Total capital cost	$ 15,600	$ 15,600	$ 15,600	$ 15,600	$ 15,600	$ 15,600	$ 24,700	$ 24,700	$ 24,700		
VEEC as % of capital cost	4.3%	2.3%	21.6%	1.3%	2.8%	0.0%	71.0%	14.2%	12.6%		
lifetime savings to owner (excluding VEECS)											
kVA reduction	14.6		14.6	14.6	14.6	14.6	90.7	90.7	43.7	kVA	
per month $	$ 218	$ 218	$ 218	$ 218	$ 218	$ 218	$ 1,361	$ 1,361	$ 655		
lifetime savings to owner	$ 26,198	$ 26,198	$ 26,198	$ 26,198	$ 26,198	$ 26,198	$ 163,299	$ 163,299	$ 78,593		
simple payback	6.0	6.0	6.0	6.0	6.0	6.0	1.5	1.5	3.1	years	
simple payback with VEEC	5.7	5.8	4.7	5.9	5.8	6.0	0.4	1.3	2.7	years	
VEEC as % of lifetime savings	2.6%	1.4%	12.9%	0.8%	1.7%	0.0%	10.7%	2.2%	4.0%		

Dependence on Behavioural Factors: None.

Potential Market Penetration: As described above, new market penetration would depend on the extent VEET certificates improve the cost benefit result for this activity. On the basis of the analysis it appears unlikely that VEECs will alter market penetration significantly. They alter the payback significantly only within a small range of units (albeit that there may be a large number of such units), there is no useful contribution in metropolitan areas due to the DLF, to have a significant effect there would need to be a high level of relatively continuous use, and that use would need to be verifiable by time of use analysis without significant compliance charges. They would have more of an effect on payback where the demand charge is lower, but this is because the existing payback is lower while the VEEC contribution remains the same. This role could therefore be for larger units again within certain restricted applications.

Effects of Installation Location: Distribution losses vary around the network. The proposed calculation method incorporates different distribution loss factors reflecting this variation.

OH&S Issues: None, the equipment is installed in an electrical switch room by a qualified electrician.

Any Other Benefits: Additional benefits from this technology are energy cost savings to the installer and a wider benefit of lower demand on and losses from the grid.

VEEC Calculation Method: The NSW ESS deemed method could be used for calculation of VEECs, with variations to reflect Victorian electricity distribution conditions.

A major change to address issues of low take up of the measure experienced in NSW would be appropriate. This activity has had a very small take up under the NSW ESS. We suggest that both the hours of use in the formula and the cut-off initial power factor may contribute to this. We find in particular that the hours of use (1750 in the NSW formula) could be altered to reflect real usage if compliance costs are low enough. Both real usage and historical power factor can be obtained either by testing or, more simply for a whole of site installation, by a data request for 15 minute interval data to the electricity supply company. Such a data request can supply data for any single authority meter at a commercial premises. This data displays the relevant 15 minute interval kWh and kVA, allowing the calculation of power factor. The number of hours for which usage is above the capacity of the installed PFC unit and the weighted average power factor for those hours can be obtained from these records and confidently used in the calculation below.

The ‘hours of use’ is a matter of special relevance to industrial and manufacturing businesses, and some commercial buildings, where PFC installations would most likely occur. Real usage will in some cases be closer to a full year of non-stop running – or about 4 times the limitation placed in the NSW formula. Further, the limitation that provides no benefit for starting positions below a power factor of 0.9, while having a logical basis, must be altered for Victorian conditions where other power factors are allowable (see above).

The formulas and explanations in italics below are taken from the Independent Pricing and Regulatory Tribunal of New South Wales (IPART)[14]. The method requires application of the two formulas. The formulas require the following input data:

- The real power component of the average site load during operating hours
- The distribution loss factor
- The initial power factor for the site load before the capacitors were installed
- The final power factor for the site load after the capacitors were installed, and
- The rating of the installed capacitors.

Real power component of the average site load
This is the average real power consumption of the site (measured in kilowatts) during operating hours. This average must be measured over a period that reflects normal operating conditions and must exclude periods not representative of normal operating conditions, such as maintenance and shutdown periods.

Distribution loss factor
The distribution loss factor (DLF) reflects the electrical distribution losses that occur in supplying electricity to the site. The installation of power factor correction capacitors at a site with a higher DLF will produce a greater amount of energy savings.

Determination of distribution loss factors for use in Victoria
There are five electricity distributors in Victoria. Each is responsible for a separate geographic region of Victoria. They are:

- Citipower
- Jemena
- Powercor Australia
- AusNet Services and
- United Energy Distribution.

In addition to these distributers, Essential Energy serves a small number of customers in Victoria. The distributor supplying a particular property can be found on a map of distributor areas in Victoria[15].

As this measure can apply to both residential and commercial / industrial we have examined the 2016 values for distribution loss factors (DLF) as shown in Table 4 below[16]. We suggest the use of two factors – one for connection to the 22 or 11 kV network at 1.03 and another for connection at 240 or 415V at 1.06. This low voltage DLF is consistent with the DLF currently used for existing VEET methods.

The NSW ESS method uses a factor for each distributor - however using a per-supplier approach in Victoria is highly complex and we suggest, unworkable due to the complex distribution maps for these suppliers.

[14] Independent Pricing and Regulatory Tribunal of New South Wales - *Method Guide Power Factor Correction Energy Savings Formula. Deemed Energy Savings Method. Energy Savings Scheme*, January 2015

[15] http://www.energyandresources.vic.gov.au/energy/electricity/electricity-distributors

[16] AEMO - *Distribution loss factors for the 2015/2016 financial year*

Table 4 Supplier distribution loss factors for Victoria.

Note: The short and long sub-transmission lines refer to the length of the line after the substation where the voltage is stepped down to the voltage in the heading. The transformer connection point refers to connection directly at a terminal (such as a major substation) or at a non-specified distance along a transmission line.

Supplier	Sub-transmission	DLF A	DLF B	DLF C	DLF D	DLF E
voltage		66/22kV	22/11 kV	22/11 kV	240/415V	240/415V
Transformer Connection point		line	terminal	line	terminal	line
Jemena	Short	1.0056	1.0119	1.0282	1.0465	1.0543
Jemena	Long	1.0292	1.0355	1.0518	1.07	1.0778
CitiPower	Short	1.0034	1.0105	1.0144	1.035	1.0403
Powercor	Short	1.0042	1.01	1.0355	1.0616	1.0703
Powercor	Long	1.0339	1.0397	1.0652	1.0913	1.1
AusNet Services	Short	1.0034	1.0118	1.0259	1.0527	1.0605
AusNet Services	Long	1.022	1.0304	1.0444	1.0712	1.079
United Energy	Short	1.0043	1.0099	1.0163	1.0391	1.0526
United Energy	Long	1.0178	1.0233	1.0297	1.0525	1.066
all	**average**	**1.0138**	**1.0203**	**1.0346**	**1.0578**	**1.0668**
Voltage group	average		1.0275		1.0623	

Note that for other items under VEET a default value of 1.06 has been used with distance modifiers.[17]

"As power often has to travel further to reach regional areas, losses are generally greater than in metropolitan areas. As a result, a regional loss factor is applied, with a multiplier of 1.04 for regional areas and 0.98 for metropolitan areas."

High voltage distribution results in lower losses, therefore a different overall factor for those with a high voltage take-off is required. Using the same regional modifiers as VEET on this matter we can propose the following DLFs for the different connections:

Table 5: Distribution Loss Factors proposed for use in VEET method.

Voltage	State-wide factor	Regional	Metro
240/415 V	1.06	1.10	1.04
22/11 kV	1.03	1.07	1.01

[17] Victorian Energy Efficiency Target (VEET) *Proposed Activity Regulation Changes* - October 2015

For consistency -
Table 5 is the recommended allocation method for the VEEC calculation. It has been calculated from two existing VEET standards, the default DLF values statewide and the distance modifiers. For example for 240/415V in the metropolitan region we have multiplied the statewide DLF of 1.06 times the distance modifier for metropolitan regions of 0.98 to equal 1.04.

Initial power factor

The initial power factor is the power factor of the load before the power factor correction capacitors are installed. This power factor should be measured at the main switchboard, or the point of supply. The initial power factor must be representative of the power factor under normal site operating conditions. If the measured initial power factor is below 0.9, the initial power factor is taken to be 0.9 when calculating the power savings.

Final power factor

The final power factor for the load is the power factor of the site load after the power factor correction capacitors are installed. This power factor should be measured at the main switchboard, or point of supply. The final power factor must be recorded under conditions similar to those when the initial power factor was recorded. If the measured final power factor is above 0.98, the final power factor is taken to be 0.98 when calculating the power savings.

Rating of installed capacitors

The electricity consumed by the power factor correction capacitors must be subtracted from the overall power savings. This is determined from the rated reactive power (measured in kvar[18]) of the installed capacitors.

Energy Savings = (Power Savings) / 1000 x (Annual operating hours) x (Site Life)

Where:

- *Power Savings, in kW, is the line loss power savings, less capacitor losses, during operating hours, and is calculated according to the equation below.*
- *Annual operating hours, in hours/year, is the number of hours per year that the site is operating and equals 1750[19].*
- *Site Life, in years, is the expected remaining lifetime of the site and the capacitors and equals 10 years.*

Power Savings (kW) =
Real Power x 0.7 x (DLF - 1) x (1 – (Initial power factor)^2/(Final power factor)^2) – 0.0039 x (Rating of installed capacitors)

Where:

- *Real Power, in kW, is the real power component of the average site load during operating hours.*
- *DLF is the distribution loss factor for the Distribution District that the site is connected to.....*
- *Initial power factor is the power factor of the load before the capacitors are installed, or 0.9, whichever is greater.*
- *Final power factor is the power factor of the load after the capacitors have been installed, or 0.98, whichever is lesser.*
- *Rating of installed capacitors, in kvar, is the rated reactive power of the installed capacitors.*

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[18] kVAR"kilovolt amperes reactive", which is reactive power.

[19] While this is the direct statement from the NSW method, it is equivalent to only 43 weeks @ 5 days per week @ 8 hours. We do not agree that the method should be limited to businesses that run only 8 hours per day on a limited timetable. There are sound logical reasons for many businesses to have reliable usage outside these hours. We strongly support assessing the real hours of application to provide proper support for this technology.

We note that the use of a factor of 0.7 (second equation) is stated by NSW IPART as dealing with the "ratio of load losses to total losses"[20]. We expect this is the factor for the percentage of current only losses along with non-technical losses and retain this in the calculation.

2.5.2 Voltage Optimisation

Recommendation: This activity is not recommended for inclusion in VEET as there is insufficient data for the development of a new deemed method for this activity. It may be eligible for inclusion in VEET using the proposed project based, measurement and verification, method that is currently under development.

Description of Activity: Installation of voltage optimisation equipment was proposed as a new activity in VEET. The efficiency of some types of electrical equipment is lower when the supply voltage is higher or lower than the equipment's design voltage (especially when it is higher). Voltage optimisation equipment can be installed to correct the variations in the supply voltage, thus enabling energy savings by improving the efficiency of the electrical equipment's operation. While the nominal voltage of the grid low voltage distribution network is commonly taken to be 240V, the target voltage is now actually 230V and electricity supply standards allow a variation between 216V and 260V. The voltage supplied by the grid to any given site varies, depending on various factors including the distance from the site to the nearest transformer, the number of connections on that line, the total load being drawn at any given time, the operation of grid connected photo voltaic solar generation systems etc. Suppliers of voltage optimisation equipment state that electricity consumption savings of between 5% and 20% are possible when this equipment is installed. In practice the savings achieved are highly variable and often much less.

The prevalence of over-voltage is difficult to quantify and may vary significantly in time as well location on the grid. The potential for energy savings varies greatly, both as a result of the voltage variation and depending on the type of equipment operated by each user. Directly connected electric motors run most efficiently at their design supply voltage, so if an installation is subject to consistent over-voltage some benefit may be obtained by correcting the supply voltage to match the design voltage. Similar savings may also be made on older fluorescent lighting with magnetic ballasts. The installation of voltage optimisation equipment on fluorescent lighting circuits is already included as an eligible activity within the existing VEET Commercial Lighting method.

Ongoing changes in electrical technology are likely to mean that the savings available from voltage optimisation will become lower over time. Motors run through variable speed drives (which are becoming more and more common) are not affected by variations in supply voltage. Similarly good quality LED lighting and other types of lighting with electronic ballasts, electronic communications and IT equipment are not affected.

Energy / Emissions Saving over Stock Average: As discussed above, energy savings are likely to be highly variable and difficult to quantify.

Energy / Emissions Saving over Business as Usual: Energy savings are likely to steadily reduce over time, with the increased use of electronically controlled equipment and reduction in directly connected equipment.

Additionality: Including this activity in VEET may assist uptake of voltage optimisers by assisting with marketing and awareness and providing some reduction to the capital cost of installing the equipment.

Dependence on Behavioural Factors: This activity would not be dependent on behavioural factors, other than behavioural variations in the use of electrical equipment, influencing the variability of the savings.

[20] Response from ESS Mailbox in regard to the nature of the factor.

Potential Market Penetration: Uptake is likely to be relatively low due to the variable nature of the energy savings and a lack of consumer awareness of voltage variation as an opportunity.

Effects of Installation Location: Energy savings would be significantly dependent on local voltage characteristics, which are likely to require local monitoring to establish.

OH&S Issues: None, the equipment is installed in an electrical switch room by a qualified electrician.

Any Other Benefits: Optimisation of voltage can be advantageous (or necessary) for correct operation of particularly sensitive electronic equipment.

VEEC Calculation Method: There is insufficient independent data currently available on power supply voltage variations in Victoria or Australia, to support a deemed calculation method. A detailed project based activity method, based on site assessment and extended field measurements would be required.

Installing voltage optimisation equipment would be an eligible activity under the proposed project based measurement and verification method, currently under development. Each site would have to be assessed on an individual basis, both to determine the energy consumption, equipment characteristics and the local supply voltage characteristics. This measurement is likely to be costly and therefore the activity would likely only be suitable for business premises which have significant numbers of voltage sensitive lights or motors.

Providing voltage optimisation to a large group of residential houses may also be possible under the proposed project based treatment and control method, also currently under development.

2.6 Australian Wind and Solar and Easy Warm Group - Solar PV to Electric Resistance Hot Water Energy Diverters

Recommendation: This activity is not recommended for inclusion in VEET as there is insufficient data to determine if the activity would result in additional greenhouse gas savings.

Description of Activity: The activities described in these two submissions involve the installation of an electronic control device intended to divert electricity generated by a residential photo voltaic (PV) solar system to an electric resistance hot water heater. Both companies market devices which are able to adjust the hot water heater element voltage to match the element's electricity demand to the available solar generation for the PV system, in order to minimise the energy exported to or imported from the grid. The devices incorporate various other features that allow users to control the timing of additional energy supply from the grid where the available solar generation is insufficient to deliver the required hot water, or in order to meet the minimum heating requirements specified by AS3498 for the prevention of legionella bacteria.

These devices do not save energy directly. The solar generation would either be directed to the hot water cylinder or to the grid. They are likely to alter the load profile of the site where they are installed, which may have greenhouse benefits by displacing higher emissions generators. However, considerably more data would be required to determine the size of this effect.

One of the submissions suggests that an indirect emissions reduction is possible, because this device is likely to motivate purchasers of residential PV solar systems to install more panels. While plausible, this effect would be difficult to quantify. Also in this scenario the resulting emissions saving/energy generation would actually come from additional solar panels, which would be eligible for Small-scale Generation Certificates (STCs) under the RET, rather than the diverter installed under VEET. In areas where the export of solar electricity to the grid is constrained by the electricity distribution network, these devices may allow for additional solar generation at the site, however there is insufficient data available to determine the impact this may have and the greenhouse savings of these devices in such circumstances.

Energy / Emissions Saving over Stock Average: As described above, this activity generates no direct energy savings.

Energy / Emissions Saving over Business as Usual: This activity generates no direct energy savings.

Additionality: This activity generates no direct energy savings.

Dependence on Behavioural Factors: This activity generates no direct energy savings.

Potential Market Penetration: PV system owners who have a feed-in tariff lower than their hot water electricity supply tariff are likely to be interested in this product. The numbers of people in these circumstances is set to increase as existing feed-in contracts expire in the future. The devices might be considered in competition with batteries, but are likely to be very much more cost effective.

Effects of Installation Location: The availability of solar energy for a given PV solar system varies with installation location.

OH&S Issues: Legionella risk would be controlled by the device in accordance with AS3498. Installation would be by a qualified electrician.

Any Other Benefits: The device would provide an economic benefit to a PV solar system owner who has a feed-in tariff lower than their hot water electricity supply tariff.

VEEC Calculation Method: This activity generates no direct energy savings.

2.7 Airconoff - Placebo Remote and Passive Occupancy Sensor for Air-Conditioners

Recommendation: These activities are not recommended for inclusion in VEET. There is insufficient data available to support the required estimate of the energy savings that may result from the activities.

Description of Activity: This submission proposes the creation of two new methods to include two related activities in VEET. The first is the provision of replacement hand-held remote controllers for reverse-cycle air conditioning (RCAC) units with a so-called "placebo effect" function for pre-set temperatures. Essentially, the placebo effect as applied here, involves making the user think that the thermostat settings range from 18 – 30 degrees, whereas the actual range has limits of say a minimum of 24 degrees for cooling and a maximum of 21 degrees for heating. This is unlikely to be effective for residential installations, where the owner is the user and would be aware of the "placebo effect" aspect of the remote controller's operation. The activity may be more effective in accommodation and institutional use, where users of the controller would be unaware of the functionality. In such situations alternative approaches are currently used to limit RCAC use.

The second proposed activity concerns the provision of a retrofit passive occupancy sensor controller to limit RCAC running times to when the space is occupied, particularly to turn off the RCAC a set time after occupancy ceases. This functionality is relatively common in more recent RCAC units along with built in timers which may be used to restrict operating times.

Energy / Emissions Saving over Stock Average: It is very difficult to predict the effectiveness of both of the proposed approaches, without results from studies to evaluate the potential savings.

Energy / Emissions Saving over Business as Usual: The provision of occupancy detectors continues to increase, as a standard feature of RCAC units. Energy efficiency of the units is also increasing with time, gradually lowering the savings from any utilisation savings that are achieved.

Additionality: Including this activity in VEET may assist with the uptake of activities by assisting with marketing and awareness and providing some reduction to the capital cost of installing the equipment.

Dependence on Behavioural Factors: Both of the proposed activities are highly influenced by RCAC user behaviour. A study would be required to determine what savings might be achieved.

Potential Market Penetration: It is likely that there would be significant challenges in marketing these activities, especially the placebo effect controller.

Effects of Installation Location: Savings would vary with climatic conditions which affect the energy consumption of RCAC units.

OH&S Issues: None, modifications to existing RCAC installations would be undertaken by a qualified electrician, in accordance with the electrical wiring code.

Any Other Benefits: Other benefits would include electricity cost savings

VEEC Calculation Method: A deemed method of calculation might be possible, if a study was available to substantiate the estimates of RCAC operation time reduction.

2.8 Watts Clever - Proposed Revision of In Home Display Abatement Factors

Recommendation: This activity is <u>not recommended for inclusion in VEET</u>**.** The report cited in the submission does not provide sufficient additional information to substantiate a change to the current abatement factors. Recent local studies on the effect of IHDs would be needed.
Description of Activity: This submission proposes an amendment to the abatement level for the existing VEET activity of installing an In Home Display (IHD), to increase from the estimated savings rate from 6.6% to 9.0%. The proposal is based on a UK report[21], which presents an analysis of a database of 110 energy monitoring programs around the world. This report does not directly reference any specific reports or individual results from the programs included. No Australian programs were included. Other studies on such programs suggest significantly lower benefits.

2.9 Embertek- Home Energy Gateway Device

Recommendation: This activity is <u>not recommended for inclusion in VEET</u>. The submission does not provide sufficient additional information to substantiate a change to the current abatement factors or to show the benefit of increasing the current 0.6W power limit. Recent, local studies on the effect of the proposed activity would be needed. Alternatively the project based treatment and control method, which is currently under development, may be more appropriate for capturing the effect of IHD's within VEET in the future.

Description of Activity: The Home Energy Gateway Device is essentially a sophisticated IHD with the implied capacity to communicate with household appliances. These additional capabilities depend on a Home Energy Management (HEM) system which includes smart appliances that have wireless communication links to the HEM. The system also utilises cloud-based data storage and analytical services.
The submissions suggest savings of 10-13% of household electricity are possible, although it does not provide calculations or study data to support this estimate.

The submission proposes either a new method for a Home Energy Gateway Device activity, to be included in VEET; or to amend the current IHD Schedule 30 to support Home Energy Gateway devices. The amendment of the schedule would require an increase in the limit of power consumption from 0.6 to 3.0 watts (about 20kWh/year).

[21] http://www.beama.org.uk/resourceLibrary/assessing-the-use-and-value-of-energy-monitors-in-great-britain.html

2.10 HeaterMate - Plug-In Electric Heater Thermostat

Recommendation: This activity is not recommended for inclusion in VEET. While this device would be effective in reducing plug-in heater energy consumption in many situations, there is insufficient data on the usage of these devices, the usage of plug-in electric heaters and the magnitude of potential energy savings, on which to base a deemed method for calculation of the VEECs.

Description of Activity: The "HeaterMate" controller is a simple and inexpensive (around $25) plug-in thermostat that sits between the power point and a plug-in heating device such as a fan heater or a column heater. The controller switches the heater off when the pre-set room temperature is reached and on again when the room temperature drops. All plug-in heaters have built-in thermostats which respond to the temperature at the appliance, but generally these do not respond well to the temperature in the room as a whole, which governs the comfort of the occupants. In principal provision of a better positioned thermostat is likely to control the heater more effectively, and save energy by turning the heater off when an appropriate temperature is reached, rather than leaving it to run on to higher temperatures. The submission proposes supply of plug-in heater controllers to residences where plug-in heaters are used, as a new activity in VEET.

The activity would not be appropriate for houses that have central heating or other wired-in heating systems in place. It is particularly effective in smaller houses, with smaller rooms where a plug-in heater is more likely to be able to heat the room beyond a comfortable temperature if it is not turned off in time. (In larger rooms or poorly sealed rooms, a small heater may not have sufficient capacity to heat the room beyond a comfortable temperature.) A large number of HeaterMate controllers have been distributed in the Future Powered Families Project, part of the Low Income Energy Efficiency Program (LIEEP) initiative conducted by Environment Victoria.

A limitation is that the device is usually plugged directly into a low wall socket, while a higher location on the wall would be a more appropriate point to measure the comfort temperature. The controller is also likely to be less effective when used on heaters with particularly short cords (where the controller may be too close to the heater). The controller would be most useful with fan heaters and column heaters. The savings gained would be lower for use with radiant heaters, which generally are run at full capacity whenever the user is present. A controller to turn off the heater if the heater is left on unintentionally, or if the room air temperature does reach a high value, would still be useful.

Due to the low cost of the controller, the value of the VEECs might completely offset the cost. If this were the case, large numbers of controller might be supplied, many of which might not be actively used. This could be addressed by limiting the activity to houses where there is no permanently installed heating and limiting the number of controllers supplied per house.

Energy / Emissions Saving over Stock Average: While data is available on the overall energy savings made by the LIEEP programme, no data is available for the plug-in controllers specifically. Given the variations in energy saving performance and the high level of dependence on behavioural factors, trials would need to be undertaken to obtain a reliable estimate for energy savings in order to calculate a VEEC abatement factor.

Energy / Emissions Saving over Business as Usual: Appliance stock and Business As Usual is unlikely to vary significantly due to the typical application with resistance heaters.

Additionality: Inclusion in VEET would substantially reduce the cost of each controller, which could be quite significant in making it affordable to potential users, leading to significant increased utilisation.

Dependence on Behavioural Factors: The energy savings delivered by this activity are highly dependent on whether plug-in heating is used and the extent to which the device remains in use. Utilisation would also vary significantly with the level of understanding by the householder of how to use the device. LIEEP recipients found the original instructions confusing, but Environment Victoria felt the device had good potential in dwellings without existing built-in heating.

Householders would be able to remove the device and move it between different heaters and different houses, such as when changing rental accommodation. There is a risk that some controllers may be misplaced or forgotten over summer etc. Utilisation may also be cut short, if the household subsequently installs a wired-in heating system.

Potential Market Penetration: Uptake is likely to be high among households which regularly use plug-in electric heating. This may result in an excess of penetration into these households, subsequent underuse, and hence underachievement of the calculated VEEC emissions savings.

Effects of Installation Location: Energy and emissions savings delivered by this activity would vary with climatic conditions and electricity supply emissions intensity in different locations.

OH&S Issues: Some safety issues are possible if the controller is not used appropriately. These include, positioning the controller too close to a radiant heater, using with a gas heater, tripping hazards from additional power cords, overloading power points. The fact that the heater would be off at times may lead to adults absentmindedly leaving unsupervised children in the room with the risk that the heater may come on again during their absence. This list of possible hazards is not exhaustive. Adequate user instructions would need to be provided. All controllers would need to be manufactured in accordance with the required standards.

Any Other Benefits: Provision of the controllers may contribute to better health outcomes in low-income households by making comfortable temperature more achievable and affordable as well as providing electricity cost savings.

VEEC Calculation Method: A deemed approach would be necessary to practically facilitate the inclusion of a low cost device such as this. Unfortunately no studies were found to support the savings energy estimate necessary for the abatement calculation. Potentially this might be addressed by making very conservative assumptions.

2.11 Solartek - Improved Electric Hot Water Cylinder Temperature Controller

Recommendation: This activity is <u>not recommended for inclusion in VEET</u>. The potential benefits are undermined by a significant compliance burden. A calculation method is provided in the event that the proponents can address the compliance burden in a manner that still creates a viable business case.

Description of Activity: This submission proposes a new activity for the installation of a retrofit heating controller and additional sensors, to provide more efficient temperature control of domestic electric hot water cylinders. The intention of the device is to allow a hot water cylinder temperature to be set lower than is normally possible with the built-in thermostat, in order to reduce standing losses. Around one third of the energy consumed by a hot water cylinder is lost through the walls of the tank. The heat loss is proportional to the temperature difference between the water inside and the air outside, so incremental savings may be made in energy usage, if the average temperature of the water is reduced.

Built-in thermostats generally do not allow the temperature to be reduced below 60°C in order to comply with the legionella prevention requirements of AS3498. However the requirements of AS3498 can also be met by storing water at a lower temperature and heating it periodically to kill any bacteria. The proposed controller would include timer and control logic that ensures that the temperature of the water reaches 60°C at least once every 7 days to ensure that these requirements are met, even if the controller is set to normally maintain the temperature much lower.

An effect of reducing the temperature set point is that the volume of hot water available for use by the household is also proportionally reduced. This may be a limitation in the applicability of the device for smaller cylinders or larger household sizes, but should not be a problem otherwise.

Setting the temperature to 50°C (for example) would produce small but significant energy savings, without greatly reducing the storage capacity.

The activity is unlikely to be attractive for very small hot water cylinders, typically mounted in cupboards or under sinks as standing heat loss is already relatively low and the energy savings achieved would be quite modest and these installations should not be included in the proposed activity. The activity should be restricted to electric resistance water heaters, with a nominal capacity of 150 litres or more. It is not suitable for heat pump or gas (due to the need for more complex control interfaces) or most solar water heaters (as the energy reductions are much smaller). The activity could also include the decommissioning of an existing electrical resistance water heater with a conventional thermostat, and replacement with a new water heater incorporating the controller described above.

Energy / Emissions Saving over Stock Average: Hot water heaters with this functionality as a standard feature are extremely rare. An estimate of the potential emissions savings has been made for small, medium and large households as defined under the current VEET abatement factor calculations for water heater upgrades. In this calculation values for the standing losses from current MEPS compliant electric water heaters, have been adopted from AS4234.[22] Standing losses are dependent on the amount of insulation provided and the difference between the internal and external temperatures. An average annual air temperature of 14.5°C has been used. For the baseline case, the average tank temperature has been calculated for a tank with a set point of 60°C by simplistically assuming that all of the daily hot water delivery happens instantaneously[23], and then calculating how much the tank temperature goes down. The average temperature of the tank can then be calculated by allowing for the time required by the element to reheat the tank to the set point temperature. In the baseline case the average tank temperature is only a little below 60°C. With the controller in operation the same approach is taken to calculate the average tank temperature with a set point of 50°C. Note that at the lower set point, a greater volume of water is required to deliver the same amount of heat, resulting in a somewhat lower average tank temperature. The weekly legionella heating cycle has been neglected in this simplified calculation, as it does not consume a significant amount of additional energy.

The energy savings resulting from lower standing losses are calculated by scaling the AS4234 standing heat loss values by the ratio of the baseline temperature difference to the controlled temperature difference.

This results in a 20-30% reduction in standing losses, which for a 15 year water heater life[24], delivers emissions savings of 1.8, 3.8 and 3.9 tonnes CO_2e for small, medium and large households respectively. This compares well with a much more detailed analysis of the controller's performance provided by the proponent for the submission, which was carried out using full TRNSYS modelling of typical installation, set up for Auckland weather conditions.

[22] This is a conservative assumption, as a small number of older, non MEPS compliant water heaters, with larger standing losses, remain in use.

[23] Assuming that the delivery of hot water is instantaneous rather taking a realistic length of time, simplifies the calculation, and only changes the average temperature of the tank by a small fraction of a degree, which does not significantly change the calculated energy saving.

[24] This is consistent with the assumed life of a water heater in the existing VEET water heater upgrade calculations. It has been assumed that the user would reinstall the controller on a new electric resistance water heater, if the original water heater was replaced less than 15 years after installation of the controller.

Details of the calculation are tabulated below:

	Small	Medium	Large		Reference
Calculate Existing Average Tank Temperature					
Hot Water Task Volume	60	150	210	l/day	*Existing Water Heater Upgrade Method*
Hot Water Set Point	60	60	60	°C	*Existing Water Heater Upgrade Method*
Average Cold Water Temp	14.5	14.5	14.5	°C	*Existing Water Heater Upgrade Method*
Standing Losses	4.79	8.64	8.64	MJ/day	*Existing Water Heater Upgrade Method*
Assumed Tank Volume	180	240	300	L	
Average Tank Temperature after delivery	44.8	54.1	58.2	°C	
Replacement Energy	11.4	28.5	39.9	MJ	
Assumed Element Size	1.8	3.4	3.6	kW	
Reheat Time	1.8	3.3	3.1	hours	
Average Temp over one day	59.4	59.6	59.9	°C	
Calculate New Average Tank Temperature					
User Set Point	50	50	50	°C	*Conservative Assumption*
New Hot Water Task Volume	76.9	193.3	269.2	l/day	
Average Tank Temperature after delivery	34.8	21.6	18.2	°C	
Average Tank Temperature over one day	49.4	48.0	48.0	°C	
Calculate Saving					
Standing Loss Saving	22%	26%	26%		
Assumed Heater Efficiency	98%	98%	98%		*Existing Water Heater Upgrade Method*
Assumed Heater Life	15	15	15	years	*Existing Water Heater Upgrade Method*
Lifetime Energy Saving	5,954	12,362	12,685	MJ	
	1,654	3,434	3,524	kWh	
Victorian Electricity Emissions Intensity	0.304	0.304	0.304	kgCO2e/MJ	
Emissions Saving	**1.8**	**3.8**	**3.9**	**t CO2e**	

Energy / Emissions Saving over Business as Usual: Implementation of MEPS requirements for water heater storage tanks has significantly reduced standing losses by requiring higher levels of insulation, which reduces the potential savings from this activity. This has been allowed for in the abatement factor calculation by conservatively using standing loss values that include current MEPS requirements as the savings baseline.

Additionality: Inclusion in VEET could make a significant difference to the uptake of these devices, by moving them from a modest payback to a good payback proposition for a consumer and assisting in marketing and awareness. It may also encourage hot water cylinder manufactures to consider building in this functionality as a standard or optional feature.

Dependence on Behavioural Factors: The proponent suggests that because the device provides feedback on energy savings through its display that it will motivate many users to reduce their consumption of hot water, creating additional energy savings in addition to the standing heat loss savings. This behavioural result is difficult to quantify, as the user response is likely to be varied. Many users will set the temperature once and not give it further attention. Others will be interested in varying the temperature depending on household activities etc. The ability to vary the tank temperature results in variable savings depending on the temperature selected. There is also a risk that some users may reset the controller to the full temperature at some time and not achieve any further savings. A conservative estimate of user behaviour has been incorporated into the energy savings estimate. If a user is sufficiently motivated to invest in this activity, it is a reasonable assumption that most users will set the temperature to a level that will provide some energy cost savings. It would be important that the suppliers of the controllers provide clear written instructions and assistance at the time of installation, to ensure users understand how to set and adjust the controllers appropriately.

Potential Market Penetration: In principle, there are a relatively large number of hot water systems in service that could make use of a temperature controller as described. Uptake is likely to be driven by the return on investment and on whether plumbers and electricians become interested in marketing the concept. The value of the VEECs is likely to be sufficient to make a significant reduction in the installation cost of the activity.

A limitation in uptake of the activity within the Victorian market is the relatively low numbers of electric resistance water heaters, currently at around 29% and declining with the progressive uptake of other technologies.

Effects of Installation Location: Standing losses vary with climatic region, proportionally to ambient air temperatures. Installations inside buildings have lower standing losses than those installed outside. Such factors must be incorporated in any calculation.

OH&S Issues: Legionella risk would be controlled by the device in accordance with AS3498. Over temperature safety measures are controlled by the existing thermostat (which remains in place and remains operational) and the safety valves already provided. Installation would require a licensed electrician.

Any Other Benefits: The device would provide an economic benefit to the user in electricity cost savings.

Quality Assurance/ Regulatory Compliance: The controller would need to be installed and commissioned by a registered electrician, in accordance with the electrical wiring code. The sensor would need to be installed by a registered plumber. Design certification and testing to AS3498 should be confirmed. A critical requirement is that the sensor is installed strictly with the controller manufacturer's instructions, in order that the controller operates correctly.

Hot water heaters are prescribed electrical equipment and are required to be certified by Energy Safe Victoria (ESV), another state regulator or an approved third party certifier. The certificate is issued to the person/company that is offering to supply the product e.g.: Aquamax, Rheem etc. With this proposed change there will be an electrical modification done to already approved equipment that is not necessarily tested or supported by the manufacturer.

It was advised by ESV that when this is performed the whole of the equipment will need to be retested and recertified for this change, and this would have to be done by the company that is offering this equipment. Such a test will cost thousands and need to be repeated for each model and brand of water heater. Potentially different sized tanks will be different models and these may have to each be individually certified. Hence involvement of the manufacturer may be essential to achieve compliance. A significant barrier to compliance therefore exists.

VEEC Calculation Method: This activity would be suitable for a deemed calculation method, largely consistent with the assumptions employed for the existing VEET activities for upgrading water heaters. Abatement factors relating to the same definitions of small, medium and large households would be employed, as well as regional factors for metropolitan and regional areas. The controller set point used in the calculation must be selected conservatively as the controller set point is user adjustable.

A simplified calculation has been provided to estimate the potential of this activity. This calculation method may be considered to be adequate to calculate the abatement factors, or alternatively a TRNSYS simulation could be conducted to provide a more refined estimate.

2.12 Embertek - Assessment of Calculation for Advanced IT Standby Controllers for Commercial Premises

Recommendations: This activity is not recommended for inclusion in VEET. There is insufficient data for the development of a new deemed method for this activity, however it may be eligible for inclusion in VEET using one of the proposed project based activities that are currently under development.

Description of Activity:
Under VEET Schedule 29 – Installation of standby power controllers (SPCs) are awarded deemed emissions savings if they comply with the required product specifications. Additional savings can be earned for advanced products where savings are demonstrated on the basis of authorised field trials.

On 6 September 2013, The Essential Services Commission (ESC) issued an information bulletin that reduced the advanced AV SPC abatement factors by 0.55 and advanced IT abatement factors by 0.63. ESC indicated that these adjustment factors were to account for changes to a range of variables in standardised Victorian household energy use, the level of market penetration and post-installation consumer behaviour.

The proponent has requested that the “0.7 multiplier” be reviewed on the basis that “….There now exist advanced SPC products that are designed principally for use in commercial premises so field trialling in residential (premises) is no longer appropriate.” In effect, they are requesting that the full emission abatement that is determined from field trials for commercial and non-residential premises be applied without the ESC adjustment factors that have applied from September 2013.

These new advanced IT boards closely communicate with the computer. When the PC enters any sort of power management mode (such as off, sleep or standby), the advanced IT board disconnects power to auxiliary devices. When the advanced IT board detects there is no PC usage, it requests the computer to enter sleep mode (saving any current data and settings) after a specified countdown period and user warnings. It is in effect power management of the PC by an external device.

Energy / Emissions Saving over Stock Average:
There is no doubt that the stock of computers in the commercial sector is large. However, there is a large variety of computers now in use, and increasingly laptops and tablets are used for many applications. Therefore this type of technology, which is not suited to laptops and tablets, is not applicable to all PCs in the commercial setting.

Limited technical data has been presented in the submission. The submission cites a number of references from the USA that provide some baseline data. This data suggests that average PC power consumption is 80W to 120W and that usage is of the order of 6000 hours per year. This is discussed further in the section on user behaviour.

The savings quoted in the references cited in the submission are based on a limited number of studies in the USA.

Two main studies are referenced. The first is by San Diego Gas & Electric (SDG&E), which monitored potential savings on 38 desktop computers for a period of 12 days at a "local" university (the location is not stated). The second reference documents "PC state" monitoring of 119 computers at the University of California Irvine (in Los Angeles - UCI).

The majority of the computers that were examined in these studies were desktop computers and they were left on most of the time. Many of them had quite low utilisation rates (average 20 to 30 hours per week – range from 0 to 80 hours per week). So it would appear that the majority of the potential energy savings are arising from the computer being put into a low power state by the SPC during periods of no utilisation, rather than energy saving of the associated peripherals (which would tend to be few in a commercial setting – mainly separate monitors, which in most cases will have low standby power via their own VESA (Video Electronics Standards Association) power management system). The SDG&E study fitted dummy controllers to the PCs and calculated the potential power reductions as if the PCs had been externally power managed. No SPC was actually fitted to the PCs as this involves complex interfacing between the SPC and the computer, and the software and hardware were not in a state that was ready to implement. Changing the power management settings on PCs at large commercial sites is often problematic as this can cut across site IT policies and management practices.

The UCI study only recorded the operating states of the monitored computers. Its conclusion was that approximately 20% of the time was spent in off or sleep mode, 20% was actively used and 60% the PC was on but was inactive. Targeting these periods where the PC was on but inactive accounted for the majority of potential energy savings. Again, most of these computers were left on most of the time and most did not have advanced power management activated.

The SDG&E study found that the baseline energy consumed by PCs was 476 kWh/year and the savings were around 65%, or 371 kWh/year (note that this includes a number of computer lab workstations that were virtually unused). These are the energy savings quoted in the submission.

While these estimates may be reasonable in some cases, a number of factors will impact on whether these savings could be achieved in practice:

- It assumes that most users in the commercial setting leave their computer on most of the time.
- Power management software is not activated most of the time.
- That most PCs have quite low levels of utilisation (probably true in terms of hours per year).

These issues are discussed in behavioural factors below.

Energy / Emissions Saving over Business as Usual:
Business as usual can reasonably be assumed to be the same as the "stock average" – see discussion above.

Additionality:
No data is provided in relation to the potential for additionality. Without the support of a scheme such as VEET, the uptake of these products is expected to be relatively low. Additionality of at least 90% could be expected.

Dependence on Behavioural Factors:
The SDG&E[25] report shows that potential savings are strongly impacted by hours of active use. For an active use of 40 hours a week the annual savings are about half of the savings where there is no active use. This is hardly surprising if the PC is left on for most of the time. Active manual power management by users (turning off when not in use) would also achieve substantial savings, but this is not documented.

[25] San Diego Gas & Electric – as cited and used in the proponents paper.

The SDG&E report states that even after installation the customer's acceptance and persistence remains uncertain due to habitual expectations and complications with IT.

The report goes on to say: "If done at a commercial location where the IT department has protocols, security, or daily computer update routines, installation may be more complex." This is likely to be a major barrier to successful widespread implementation.

The obvious solution in the commercial IT setting is to boost the level of automatic power management in PCs so that they enter sleep mode when the PC is not being actively used. The UCI report notes that levels of automatic power management implementation are generally low (of the order of 20%). Addressing this issue at an IT policy level within large organisations will most likely achieve a similar level of benefits and would have lower or, at worst, comparable implementation complexity as the installation of advanced IT SPCs.

Achieving higher levels of automatic power management on the one hand and interfacing advanced IT SPC boards to different computers on the other present similar barriers. While the savings from a well implemented SPC board may be higher than effective automatic power management (because of possible savings from auxiliaries, assumed to be few in the commercial setting), the differences will be modest. The largest problem facing all SPC systems is the poor experience some users have with the equipment. Given the complex interface requirements of the advanced IT SPC boards, this is not likely to be any better than existing AV or IT SPC boards. Surveys in Victoria, South Australia and the ACT indicate moderate to poor user satisfaction with SPCs in general and a relatively high level of removal after short periods due to the poor user experience. This indeed was one factor that led ESC to scale down the abatement for these types of SPC board in 2013. Until some long term field trials establish the viability and salience of these new advanced IT SPC boards in the commercial setting, there is nothing to suggest that the current approach and VEET abatement factors should be changed.

Potential Market Penetration:
The potential market penetration is very high. However, this is highly dependent on user acceptance of the technology and the demonstration of tangible savings in practice. Any negative impact on user experience or operation will most likely result in strong resistance to the technology and its removal after installation. This is an area of high risk for VEET that needs to be carefully monitored and controlled for this type of product (easy to install, easy to remove).

The advanced IT SPC boards are not likely to be very useful for laptops or tablets as these devices are often moved around and operate without mains power for extended periods. Laptops and tablets already have high levels of automatic power management implemented to maximise battery life, so the advanced IT SPC will save little additional energy.

Effects of Installation Location: Location will have no effect on this activity.

OH&S Issues: No significant issues related to OH&S are likely. Correct installation by a trained professional would be required, especially to ensure correct interactions between the SPC and the computer.

Any Other Benefits: There are no other benefits of significance.

VEEC Calculation Method:
The current VEET method allows (encourages) field trials of advanced SPCs in order to assess the abatement value for the relevant product. Previous reviews have suggested that some of the assumptions and baselines for the calculation of savings from field trials need to be revisited in order to get more realistic estimates of savings. Manufacturers can hand pick installations in order to maximum the savings in field trials. Typically these field trials are of short duration (2 weeks).

More robust data would be obtained from longer term field trials and from ex-post metering in selected SPC installations. Given the likely complexity of implementing new advanced IT SPC boards in the commercial setting, some longer term trials at larger commercial sites are recommended to more fully assess the issues in implementation, the likely energy savings during operation and the impact on users (if any). Given that this is potentially a large commercial activity, these assessments should be done independently of the product vendor.

The savings generated by this activity are also likely to be able to be included in the generic, "technology neutral", Measurement and Verification based approaches that are currently under development.

2.13 Yanmar - Gas Powered Reverse Cycle Air Conditioning

Recommendation: This activity is not recommended for inclusion in VEET at this time. There is insufficient data on this technology for the development of a new deemed method for this activity. Closing the design standard and testing standard gap is recommended prior to inclusion of this activity.

Description of Activity: This submission proposes a new activity for inclusion in VEET, which involves the use of a gas powered engine to drive the compressor in a commercial or large residential, reverse cycle or heating only, air-conditioning system, instead of an electric motor. This is a mature technology that is widely used in Japan, to the extent that there is a Japanese design standard (JIS B8627-1, *Gas Engine Driven Heat Pump Air Conditioners*). The operation of the engine is fully automatic and the equipment installed inside the building is identical to conventional electrically powered systems, so there is no difference in operation apparent to building occupants.

Using a gas powered engine instead of an electric motor actually results in an increase in the energy consumed on site, as the engine is likely to be around 40% efficient and the electric motor around 90%. The resulting emissions however are significantly reduced due to the high emissions intensity of grid electricity in Victoria. Depending on the prevailing relative price of gas and electricity, users are also likely to achieve a reduction in the cost of energy required to operate their air-conditioning system.

Gas powered air-conditioning has not been widely taken up in Australia due to the significantly larger capital cost of the engine compared with an electric motor. The proponent suggests that the value of VEET certificates would make this option attractive enough to greatly increase the number of installations.

The available sizes of the units makes the model range somewhat more applicable to commercial air-conditioning installations, as only the smallest system (18kW) would be suitable for average houses. However a very large number of these may be part of the future market and other manufacturers may have smaller units. Each installation would displace a relatively large quantity of emissions, so if the economic return was favourable, a significant number of installations is likely, potentially delivering a significant emissions reduction.

Energy / Emissions Saving over Stock Average: Significant emissions reduction per installation is likely.

Energy / Emissions Saving over Business as Usual: Significant emissions reduction per installation is likely. The emissions savings would be lower for more modern, more efficient air-conditioning systems, as less mechanical energy would be required, but they would still be significant. Emissions savings per installation would vary greatly depending on the heating and cooling load that needed to be served.

Additionality: Capital cost is currently the major barrier to the uptake of this activity. Inclusion in VEET has the potential to greatly improve the pay back proposition, particularly for commercial installations.

Dependence on Behavioural Factors: The controls and performance of gas powered air-conditioning systems would be identical to an electrically driven system, from the building occupant's point of view. Behavioural factors would have no influence on the relative emissions savings of the gas powered system, compared with the electrically powered system. Behavioural factors do however affect the estimation of the heating and cooling load of air-conditioning systems in general, with variations in user comfort preferences, hours of use, thermostat settings, opening of windows, opening and closing of doors etc., all having an impact on the final energy consumption of the system

Potential Market Penetration: If cost/benefit economics are favourable then a relatively high level of penetration within the commercial air-conditioning market could be achieved. The proponent suggests that the assistance of VEET certificates is necessary to achieve this. It will also be dependent on the relative cost of electricity and gas.

Effects of Installation Location: Climatic variations affect the input energy required by air-conditioning systems, in turn affecting the emissions savings achieved by each installation.

OH&S Issues: Gas safety issues are regulated by existing installation rules. The absence of an existing Australian Standard for these devices creates a gap that needs to be addressed.

Any Other Benefits: Energy cost savings are likely for most installations, depending on the relative cost of electricity and gas. The technology may have a capital cost advantage on commercial sites where the electricity supply infrastructure is close to full capacity. Using gas instead of electricity as the energy source in this situation may result in avoiding electrical supply system upgrades that would otherwise be required.

VEEC Calculation Method: A deemed calculation method similar to the existing method for, say, “replacement of ducted reverse cycle with high efficiency reverse cycle” would be suitable. A method similar to these existing space heating activities would be possible and could use the same large table of deemed factors, as the capacity and utilisation of commercial heating and cooling installations varies across a large range, the combination of different climatic zones across Victoria, differing deemed electrical emission savings in different regions, and widely varying original usage in homes and commercial situations creates a large number of combinations.

However, for this one range of models there are 12 model versions and no Australian testing standard for their claimed efficiency exists. Closing the design standard and testing standard gap is recommended prior to inclusion of this activity.

This activity would also be suitable for inclusion in VEET through the proposed project based, measurement and verification method that is currently under development.

3. Summary Matrix

Proposed Activity	Energy Savings vs Stock Average	Energy Savings vs Business As Usual	Additionality	Dependence on Behavioural Factors	Likely Market Penetration	Other Benefits	OH&S Issues	Effect of Location	Suitable Calculation Method	Recommended for Inclusion as a New Method
Low Flow Tap Conversion	Small	Small & Reducing	Poor due to low VEEC value	None	Already high without VEET	Water Saving	None	Savings vary with climate	Deemed	**NO** Insufficient energy savings
Reflective Roof Paint	Small	Small	Poor	Mostly Unaffected	Poor, due to high cost of treatment	Thermal comfort, Extend roof life	Working at heights	Savings vary with climate	M&V	**NO** Suited to proposed new project based methods
Thermostatic Shower Valve	Small	Small	High	Savings highly dependent on user	Uncertain	Water Saving	None	Savings vary with climate	Deemed	**NO** Insufficient study data available
LED Lighting with extra functions	Uncertain	Uncertain	Likely to be Poor	Savings highly dependent on user	Low	None	None	None	Deemed	**NO** Insufficient study data available
Power Factor Correction	Small	Small & Reducing	Varies with installation size and application (Refer to text)	None.	Poor (for most installations)	Energy Cost	Electrical Safety	Savings vary with Grid Location	Deemed or M&V	**NO** Insufficient uptake likely
Voltage Optimisation	Small & Highly Variable	Small & Reducing	Uncertain	None.	Uncertain	Reliability of Sensitive Equipment	Electrical Safety	Savings vary with Grid Location	M&V Commercial Lighting	**NO** Insufficient study data available
Solar PV to Hot Water Diverter	None.	None.	None.	None.	n/a	Energy Cost	Electrical Safety	n/a	n/a	**NO** Insufficient data
Placebo Air-Conditioner Remote	Uncertain	Uncertain	Uncertain	Savings highly dependent on user	Very Low	None	None.	n/a	Deemed	**NO** Insufficient data

Proposed Activity	Energy Savings vs Stock Average	Energy Savings vs Business As Usual	Additionality	Dependence on Behavioural Factors	Likely Market Penetration	Other Benefits	OH&S Issues	Effect of Location	Suitable Calculation Method	Recommended for Inclusion as a New Method
Passive Occupancy Sensor for Air conditioners	Uncertain	Uncertain	Uncertain	Savings highly dependent on user	Very Low	None	None.	n/a	n/a	**NO** Insufficient data
Amendment of in Home Display Abatement Factors	Small	Small	Uncertain	Fundamental	Uncertain	None	None	Savings vary with climate	Existing	**NO** Insufficient study data available
Plug-In Electric Heater Thermostat	Moderate but highly variable	Moderate but highly variable	Likely to be Very High (Note risks discussed in text)	Savings highly dependent on user	Very High (depending on VEEC value)	Energy Cost, Thermal Comfort	Various, electrical & fire Hazards (Refer to text)	Care required for set up location in house	Deemed	**NO** Insufficient study data available
Hot Water Cylinder Temperature Controller	Moderate	Moderate	Likely to be Poor	Dependent on user settings	Moderate	Energy Cost	Electrical Safety / Certification	Savings vary with climate	Deemed	**NO** Significant Compliance burden
Assess Calculation for Standby Controllers	Uncertain	Uncertain	Uncertain	Very High	Uncertain	None	None	None	Existing (Schedule 29B)	**NO** Insufficient study data available
Gas Engine driven Reverse Cycle Air-Conditioning	Significant Emissions Savings (No Energy Saving)	Significant Emissions Savings (No Energy Saving)	Likely to be Significant	None	Moderate	Energy Cost	Gas Safety	Savings vary with climate	M&V	**NO** Insufficient testing data currently available for a deemed calculation method

Contact
Philip Harrington
Senior Principal – Carbon & Energy
pharrington@pittsh.com.au
0419 106 449

transport | community | mining | industrial | food & beverage | carbon & energy

Brisbane
Level 2
276 Edward Street
Brisbane QLD 4000
T: (07) 3221 0080
F: (07) 3221 0083

Canberra
PO Box 3124
Manuka ACT 2603
T: (1300 748 874

Devonport
Level 1
35 Oldaker Street
PO Box 836
Devonport TAS 7310
T: (03) 6424 1641
F: (03) 6424 9215

Hobart
199 Macquarie Street
GPO Box 94
Hobart TAS 7001
T: (03) 6210 1400
F: (03) 6223 1299

Launceston
Level 4
113 Cimitiere Street
PO Box 1409
Launceston TAS 7250
T: (03) 6323 1900
F: (03) 6334 4651

Melbourne
Level 1, HWT Tower
40 City Road
Southbank VIC 3006
PO Box 259
South Melbourne VIC 3205
T: (03) 9682 5290
F: (03) 9682 5292

E: info@pittsh.com.au
W: www.pittsh.com.au

incorporated as
Pitt & Sherry (Operations) Pty Ltd
ABN 67 140 184 309

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