IPART

Independent Pricing and Regulatory Tribunal
New South Wales

Power Factor Correction Energy Savings Formula

Method Guide

Energy Savings Scheme

May 2017

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Contents

1 About this document

The NSW Energy Savings Scheme (**ESS**) seeks to reduce energy consumption in NSW by creating financial incentives for organisations to invest in energy saving projects.

The other objects of the ESS are to:

- assist households and businesses to reduce energy consumption and energy costs
- make the reduction of greenhouse gas emissions achievable at a lower cost, and
- reduce the cost of, and need for, additional energy generation, transmission and distribution infrastructure.[1]

Electricity retailers and other mandatory participants (**Scheme Participants**) are obliged to meet energy saving targets. Energy savings can be achieved by installing, improving or replacing energy saving equipment. Persons that become Accredited Certificate Providers (**ACPs**) can create energy savings certificates (**ESCs**) from these activities and then sell those ESCs to Scheme Participants. The Independent Pricing and Regulatory Tribunal of NSW (**IPART**) is both the Scheme Administrator and Scheme Regulator of the ESS.[2]

This document provides guidance about how the Power Factor Correction Energy Savings Formula (**PFC**) method of the ESS operates, some of the key requirements that must be met when using the method, and how to calculate energy savings for a Recognised Energy Saving Activity (**RESA**) and create ESCs. This document should be used by:

- applicants seeking accreditation as a certificate provider, to assist them in completing their application,[3] and
- those persons who are already ACPs, to assist them in accurately calculating energy savings using this method.

1.1 Legislative requirements

This document is a guide only and is not legal advice. The legal requirements for ACPs participating in the ESS are set out in:

- Part 9 of the *Electricity Supply Act 1995* (**Act**)
- Part 6 of the *Electricity Supply (General) Regulation 2014* (**Regulation**), and
- the *Energy Savings Scheme Rule of 2009* (**ESS Rule**).

ACPs are also required to meet any additional accreditation conditions as set out in their Accreditation Notice.

1 *Electricity Supply Act 1995*, section 98(2)
2 *Electricity Supply Act 1995*, sections 153(2) and 151(2)
3 A full explanation of the application process is provided in the Application Guide www.ess.nsw.gov.au/How_to_apply_for_accreditation/The_application_process. Please ensure you read this document and the Application Guide in full before applying for accreditation.

2 Method overview

The PFC method provides a way to calculate and create ESCs from the energy savings achieved by installing power factor correction capacitors at sites connected to the NSW electricity network.

3 Requirements that must be met

The information below is guidance about the requirements of the method. This is not an exhaustive list of requirements, and you should ensure that you are familiar with your obligations under the Act, Regulation, ESS Rule and any conditions of your accreditation.

3.1 Energy saver

An ACP can only calculate energy savings and create ESCs if the ACP is the 'energy saver' under the ESS Rule. The ACP must be the energy saver as at the implementation date. An energy saver can be either:

- **the original energy saver** – which, under the PFC method, is the purchaser (discussed below), or
- **the nominated energy saver** – which is someone the original energy saver has nominated as the energy saver by completing a Nomination Form.[4]

An ACP that is the original energy saver must be accredited as an ACP **prior to** the implementation date in order to create ESCs from an implementation.

An ACP that is a nominated energy saver must:

- be **accredited** as an ACP **prior** to the implementation date and before the nomination is made,[5]
- have a documented procedure for obtaining the nomination from the original energy saver, and
- be **nominated** by the original energy saver **on or before** the implementation date. The nomination is taken to occur on the date that the nomination form is signed by the original energy saver.

3.1.1 Purchaser

In general, the purchaser is the person who purchases or leases the goods or services that enable the relevant energy savings to be made. However, the following persons cannot be a 'purchaser' and therefore cannot be an original energy saver under the PFC method:

- an ACP who is not the owner, occupier or operator of the relevant site,[6]

4 Available at: www.ess.nsw.gov.au/Accredited_Certificate_Providers/Templates

5 The ESS website provides information on applying to become an ACP at: www.ess.nsw.gov.au/How_to_apply_for_accreditation.

- a person who purchases or leases the goods or services for the purpose of reselling the end-user equipment, unless the resale will be an inclusion in a contract for the sale of land or a strata scheme lot.[7]

3.1.2 Network service provider power factor correction

A network service provider who installs power factor correction capacitors on their network may qualify as the purchaser. However, the installation of power factor correction capacitors by a network service provider is ineligible if:

- the capacitors are installed to meet a mandatory legal requirement, such as a 'reliability corrective action' undertaken to meet a service standard set under the National Electricity Rules (**NER**), or
- the installation of the capacitors satisfies a regulatory investment test under the NER when revenue from the ESS is not included.

3.2 Implementation and Implementation Date

The ESS Rule defines 'implementations', 'implementation dates' and 'site' (explained below). These concepts are used to determine the number of ESCs, and from when they can be created.

3.2.1 Implementation

An implementation is the delivery of an energy saving activity (called a 'RESA' in the ESS Rule)[8] at a site.

3.2.2 Implementation date

For ACPs that use the PFC method, the implementation date is the date the power factor correction capacitors are installed.

3.2.3 Site requirements

The site where the power factor correction capacitors are installed must meet the following requirements to be eligible under this method.

Supply voltage

The site where the power factor correction capacitors are installed must be connected to the NSW electricity network at a voltage less than 50 kilovolts (**kV**). This voltage is the voltage at the point of supply as defined by the Service and Installation Rules of New South Wales.[9]

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6 ACPs that are nominated Energy Savers will typically fall under this category.
7 Wholesalers will typically fall under this category.
8 A RESA must meet all of the criteria set out in clause 5.3 and 5.4 of the ESS Rule.

Main switchboard

The power factor correction capacitors must be installed at the main switchboard, which is the switchboard where the main switches that control the whole electrical installation are located. The main switchboard is typically identified with a label (eg, main switchboard). The Australian/New Zealand Wiring Rules[10] provide further clarification on whether a switchboard is considered a main switchboard.

3.3 Equipment requirements

3.3.1 Power factor correction

The power factor correction provided at the site must be supplied through capacitors. Eligible power factor correction systems include:

- switched capacitor banks
- static var[11] compensators (**SVCs**), as they use capacitors to provide their reactive power, and
- static synchronous compensators (**STATCOMs**), as they also employ capacitors.

Synchronous condensers and 'overly excited' generators are not eligible as they do not use capacitors to provide the power factor correction.

3.3.2 Power factor after installation

The power factor correction capacitors must improve the power factor of the site to a minimum of 0.9 lagging.

The installation of power factor correction capacitors must not result in a leading power factor or interfere with the operation of frequency injection load control systems.[12]

3.3.3 New capacitors

The power factor correction capacitors installed at the site must be new.

3.4 Legal requirement to install

For power factor correction capacitors to be eligible under this method, they must not be installed as part of a mandatory program of installation, eg, to meet a legal or mandatory requirement to provide power factor correction.

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9 Available here: www.resourcesandenergy.nsw.gov.au/energy-supply-industry/pipelines-electricity-gas-networks/network-connections/rules

10 The Australian/New Zealand Wiring Rules is also known as: AS/NZS 3000:2007 Electrical installations.

11 "var" is reactive power (volt amperes reactive).

12 These are requirements of the Service and Installation Rules of New South Wales. www.resourcesandenergy.nsw.gov.au/energy-supply-industry/pipelines-electricity-gas-networks/network-connections/rules

3.5 Electrical work

The power factor correction equipment must be installed in accordance with the requirements of the relevant electrical and safety standards, including the Service and Installation Rules of New South Wales and the Australian/New Zealand Wiring Rules.[13]

3.6 Minimum requirements for conduct of representatives

The Scheme Administrator has established minimum requirements for the conduct of ACPs and their representatives. This includes ACP responsibilities for:

- training representatives
- maintaining a register of representatives
- ensuring there is a formal, documented, signed and enforceable (legally binding) contract or agreement in place for each representative, and
- providing appropriate customer service.

ACPs are accountable for all ESS activities conducted by employees, third parties and other representatives. This includes all aspects of an activity for which they create ESCs, from the initial engagement with customers, through to the final quality assurance of documents. ACPs will be held responsible for all actions, omissions and information provided by representatives acting on their behalf under the ESS – regardless of any contract or agreement with other parties. For more information, refer to ESS Notice 01/2013 (amended July 2014) Minimum requirements for conduct of persons acting on behalf of ACPs.[14]

4 Calculating energy savings

The relevant equations and tables used to calculate energy savings using the method are provided in Appendices A and B of this guide. Under the ESS Rule, energy savings comprise both 'electricity savings' and 'gas savings'.

4.1 Electricity savings

The electricity savings from an implementation of the method can be calculated using Equations 13 and 14 of the ESS Rule (reproduced in Appendix A of this guide). The electricity savings are calculated as the power savings over the expected lifetime of the site and power factor correction capacitors. For the purposes of this method, this lifetime is taken to be 10 years.

13 The Australian/New Zealand Wiring Rules are also known as AS/NZS 3000:2007 Electrical installations.
14 Refer: www.ess.nsw.gov.au/ESS_Notices_and_Updates

4.1.1 Regional Network Factor

The equation to calculate electricity savings includes a regional network factor. The applicable regional network factor is based on the postcode of the site and can be found in Table A24 of the ESS Rule (reproduced in Appendix B of this guide).

4.1.2 Power savings

The power savings calculated in Equation 14 of the ESS Rule are equal to the line loss power savings less capacitor losses. Equation 14 requires the following inputs:

- 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 due to a low power factor will produce a greater amount of energy savings.

Table A19 of the ESS Rule (reproduced in Appendix B of this guide) specifies a DLF for each Distribution Network Service Provider (**DNSP**) in NSW. There are three DNSPs in NSW and each is responsible for electrical distribution in separate geographic regions of NSW, known as distribution districts.

There are two easy ways to determine which DNSP is responsible for the supply of electricity to a site:

- referring to the electricity bill or connection agreement for the site, or
- checking the local government area the site is in.

These are outlined further below.

Determining the DSNP from the electricity bill

Most electricity bills identify the DNSP under the 'Faults and Emergencies' section, as the DNSP is responsible for maintaining and repairing the network.

Determining the DSNP from the local government area

The DNSP can also be determined using the local government area (council) where the site is located, as each distribution district is aligned with local government area boundaries. Schedule 3 of the Act specifies the DNSP for each distribution district.

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[15]) of the installed capacitors.

4.2 Checking energy savings measurements

The formula provided below will assist you to calculate the theoretical capacitor rating needed to achieve the change in power factor for a given load. You can use this formula to check that your measurements of the power factor and real power are accurate.

$$Required\ kvar\ =\ Real\ Power(kW)\ \times\left(\frac{\sqrt{1-(initial\ pf)^2}}{initial\ pf}\ -\ \frac{\sqrt{1-(final\ pf)^2}}{final\ pf}\right)$$

15 "kilovolt-amperes reactive", which is reactive power.

Where:

- *initial pf* is the power factor of the load before the capacitors are installed, or 0.9, whichever is greater, and
- *final pf* is the power factor of the load after the capacitors are installed, or 0.98, whichever is lesser.

4.3 Gas Savings

The gas savings from this method will always be equal to zero (as, under the ESS Rule, gas savings are not calculated for this method and are therefore not applicable).

5 Calculating and creating ESCs

Equation 1 of the ESS Rule is used to calculate the number of ESCs that may be created from the energy savings calculated in relation to an implementation.

Equation 1

$$Number\ of\ Certificates = \Sigma_{Implementations}\ Electricity\ Savings \times Electricity\ Certificate\ Conversion\ Factor + Gas\ Savings \times Gas\ Certificate\ Conversion\ Factor$$

5.1 Applying to register ESCs

Certain information must be submitted to the Scheme Administrator **before** an ACP applies to register ESCs.[16] ACPs are to provide the required information by completing an *Implementation Data Sheet*[17] and submitting it through the ESS Portal.[18] The *Implementation Data Sheet* will include a calculation of the number of ESCs to be created in accordance with Equation 1 in the ESS Rule. This calculation involves multiplying the electricity savings arising from the implementation or implementations by the certificate conversion factor for electricity (1.06).[19]

The result is the total number of ESCs that ACPs can apply to register from the implementation or implementations. If the result is not a whole number, it is rounded **down** to the nearest whole number.

There are no restrictions on how many implementations can be bundled together in the same *Implementation Data Sheet*. However:

- ACPs must apply to register all ESCs included in an *Implementation Data Sheet* in a single application
- ACPs cannot split energy savings calculated from a single implementation across two or more *Implementation Data Sheets*, and

16 *ESS Rule*, cl 6.8
17 Available at: http://www.ess.nsw.gov.au/Registry/Registering_certificates
18 Information and access to the portal can be found here: www.ess.nsw.gov.au/ESS_Portal
19 *The Act*, s 130(1)(a). This may be amended by regulations: see *the Act*, s 130(3).

- each *Implementation Data Sheet* must only include the calculation of energy savings that are taken to have occurred in the same calendar year (commonly referred to as 'vintage').

When determining how many implementations to bundle in the same *Implementation Data Sheet*, ACPs should consider:

- the ESC creation limit specified in their Accreditation Notice, as they must be able to register all the ESCs in the bundle at the same time, and
- the cost of registering the ESCs.[20]

More information on applying to register the creation of ESCs can be found on the ESS website.[21]

6 Minimum required records

ACPs are required to keep records in respect of a RESA, including records of:

- the location in which the RESA occurred
- the energy savings arising from that RESA
- the methodology, data and assumptions used to calculate those energy savings, and
- any other records specified by the Scheme Administrator.[22]

ACPs must retain records for at least six years, in a form and manner approved by the Scheme Administrator. Each ACP's Accreditation Notice may include a condition requiring that the ACP's record keeping arrangements are consistent with the *ESS Record Keeping Guide*.[23]

Table 6.1and Table 6.2 below describe the minimum documents you must keep as a record of the energy savings from your project. You must collect the required documents for each implementation of your activity.

20 The ESC registration fee must be paid in a single payment for all ESCs registered in a single bundle. Payment for a single bundle cannot be split into two payments. Refer: www.ess.nsw.gov.au/Registry/Registering_certificates

21 Available at: www.ess.nsw.gov.au/Registry/Creating_certificates

22 *Electricity Supply (General) Regulation 2014*, cl 46

23 Available at: www.ess.nsw.gov.au/Accredited_Certificate_Providers/Record_keeping_arrangements

Table 6.1 Minimum required records for all implementations - general requirements

Requirement	Document	Description
Implementation date	Completion/commissioning report **or** Certificate of Compliance – Electrical Work (CCEW) **or** Tax invoice	The document must clearly show the date the power factor correction equipment was installed.
Implementation address	Completion/commissioning report **or** Certificate of Compliance – Electrical Work (CCEW) **or** Tax invoice	The document must clearly show the location of the site where the power factor correction equipment was installed.
Energy Saver	Sales ledger **or** Tax invoice	The document must clearly show that the purchaser paid for the power factor correction equipment.
Nomination	Nomination form (not required if you are the original energy saver, ie, the purchaser)	The nomination form must: ▼ be in the required form (ie, using the relevant template available from the ESS website), and ▼ be signed by the original energy saver on or before the implementation date.
Energy saving calculations	The spreadsheet or calculation tool used to calculate energy savings from each implementation.	The document must clearly show your calculation of energy savings in accordance with equations 13 and 14 of the ESS Rule.

Table 6.2 Minimum required records for all implementations - activity requirements

Requirement	Document	Description
Capacitors installed at the main switchboard	Provide **two** of the following **three** documents: ▼ single line diagram ▼ schematics ▼ photographs (geo-tagged)	The document must: ▼ identify the main switchboard, ▼ identify the connection of the power factor correction installation, and ▼ show that the power factor correction capacitors are installed at the main switchboard. The photograph must: ▼ be clear and in focus, and ▼ identify the power factor correction capacitors and the connection to the main switchboard.[a]
Supply voltage	Single line diagram **or** Schematics **or** Connection or Supply Agreement	The single line diagram must: ▼ identify the site, ▼ show the point where the site connects to the NSW electricity network, and ▼ show the voltage at the connection point. The agreement must: ▼ identify the site, and ▼ identify the supply voltage.
Real power	Site interval data[b] **or** Electricity retailer report	The document must: ▼ show the average real power during normal operating hours, and ▼ identify the time period over which the measurements were taken.
Initial power factor	Site interval data[b] **or** Electricity retailer report	The document must: ▼ show the average power factor during normal operating hours before the power factor correction equipment was installed, and identify the time period over which the measurements were taken.
Final power factor	Site interval data[b] **or** Electricity retailer report	The document must: ▼ show the average power factor during normal operating hours after the power factor correction equipment was installed, and ▼ identify the time period over which the measurements were taken.

Requirement	Document	Description
Distribution network service provider (DNSP)	Electricity bill **or** Connection agreement **or** Single line diagram **or** Council rates notice (or other similar council document)	The document must identify: ▼ the location of the site where the power factor correction equipment was installed, and ▼ the DNSP responsible for the supply of electricity to the site.[c]
Rating of installed capacitors	Single line diagram **or** Manufacturer specification **or** Photographs (geo-tagged) **or** Completion or commissioning report **or** Tax invoice	The document must: ▼ identify the site where the power factor correction capacitors were installed, and ▼ show the rating of the installed capacitors.

a A photograph showing the main switchboard together with a photo of the switchboard panel containing the switchgear for the power factor correction installation is sufficient.

b Site interval data must be measured at the main switchboard or connection point.

c The council rates notice may evidence this by showing the local government area the site is located in.

7 Glossary

Words which are defined in the ESS Rule and used in this Method Guide have the same meaning in this Method Guide as in the ESS Rule, unless the context requires otherwise.

Term	Definition
ACP	Accredited Certificate Provider
DLF	Distribution Loss Factor
DNSP	Distribution Network Service Provider
Energy saver	Refer to section 3.1 of this guide
ESC	Energy Savings Certificate
ESS	Energy Savings Scheme
ESS Rule	*Energy Savings Scheme Rule of 2009*
Implementation	Refer to section 3.2 of this guide
Implementation Date	Refer to section 3.2 of this guide
kV	Kilovolt
kvar	Kilovolt-amperes reactive
kW	Kilowatt
kWh	Kilowatt-hour
MWh	Megawatt-hour
PF	Power Factor
PFC	Power Factor Correction
Purchaser	Refer to section 3.1 of this guide
RESA	Recognised Energy Saving Activity
Var	Volt-amperes reactive

Appendices

A Equations to calculate energy savings

A.1 Clause 9.6 of the ESS Rule

Equation 13

For each Implementation:

$$\textit{Electricity Savings} = \textit{(Power Savings) / 1000 x (Annual operating hours) x (Site Life) x Regional Network Factor}$$

Where:

- *Power Savings*, in kW, is the line loss power savings, less capacitor losses, during operating hours, and is calculated according to **Equation 14;**
- *Annual operating hours*, in hours/year, is the number of hours per year that the Site is operating and equals 1750; and
- *Site Life*, in years, is the expected remaining lifetime of the Site and the capacitors and equals 10.
- *Regional Network Factor*, is the value from Table A24 of Schedule A corresponding to the postcode of the Address of the Site or Sites where the Implementation(s) took place.

Equation 14

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

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, as detailed in Table A19 of Schedule A;
- *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; and
- *Rating of installed capacitors*, in kvar, is the rated reactive power of the installed capacitors.

B Tables from the ESS Rule

Table A19: Distribution Loss Factors (DLF) for losses between the Subtransmission network and Low Voltage connection points

Distributor	Distribution District	DLF
Endeavour Energy	Endeavour Energy	1.054
Essential Energy	Essential Energy	1.074
AusGrid	AusGrid	1.043

Table A24: Regional Network Factors

Postcode of Site where Implementation occurred	Regional Network Factor
2311-2312	1.03
2321	1.03
2324	1.03
2329	1.03
2338-2490	1.03
2536-2537	1.03
2545-2551	1.03
2579-2599	1.03
2619-2739	1.03
2787	1.03
2791-2844	1.03
2850-2880	1.03
3585	1.03
3644	1.03
4383	1.03
All other postcodes	1