IPART
New South Wales

Independent Pricing and Regulatory Tribunal

# Method Guide
# Power Factor Correction Energy Savings Formula

## Deemed Energy Savings Method

**Energy Savings Scheme**
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## Document Control

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# Contents

# 1 About this Guide

This guide details how the Power Factor Correction Energy Savings Formula Method (method) of the NSW Energy Savings Scheme (ESS) operates, the method eligibility requirements, and how to calculate energy savings. This guide should be used by:

- applicants who are seeking accreditation as an Accredited Certificate Provider (ACP), to assist them in completing their application, and
- those persons already accredited (ACPs), to assist them in accurately calculating energy savings under this method.

The *Application Form: Part B – Method Details Power Factor Correction Energy Savings Formula* (Application Form: Part B - Method Details)[1] can be found on the apply for accreditation webpage for this method. The Application Form: Part B - Method Details can be completed by applicants using the information provided in this guide.

# 2 Method overview

The Power Factor Correction Energy Savings Formula Method provides an incentive to improve the power factor at a site, which achieves energy savings through reducing the losses in the electricity distribution network.

The method provides a way to calculate the energy savings (in megawatt hours, MWh) and create Energy Savings Certificates (ESCs) from the energy savings achieved by installing power factor correction capacitors at sites connected to the NSW electricity network.

# 3 Method eligibility

A number of requirements must be met for the creation of ESCs using this method, which are outlined below.

## 3.1 Energy saver

Only an ACP, who is also an energy saver, can create ESCs using this method. There are two types of energy savers, as described in the following sections.

[1] The Application Form: Part B - Method Details can be found on the ESS website at: http://www.ess.nsw.gov.au/Methods_for_calculating_energy_savings/Power_Factor_Correction/Apply_for_Power_Factor_Correction

### Original energy saver

Under this method, the original energy saver is the purchaser (see section 3.2 of this guide).

### Becoming the energy saver through nomination

Alternatively the purchaser can nominate an ACP as the energy saver by completing a nomination form generated from the Nomination Form Template specific to this method.[2]

If you are a nominated energy saver, you must have a documented procedure showing how you will engage with the purchaser to obtain your energy saver nomination.

## 3.2 Purchaser

For a power factor correction installation to be eligible, the power factor correction capacitors must be purchased or leased by a person who will directly benefit from the ongoing end-use service (i.e. the improvement in electricity supply) that the capacitors provide.

### 3.2.1 Network service provider power factor correction

A network service provider who installs power factor correction capacitors on their network may also qualify as the purchaser, as they directly benefit from the improved power factor and reduced losses on their network.

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.

## 3.3 Implementation and Implementation Date

Under the Power Factor Correction Energy Savings Formula Method, an implementation is the installation of power factor correction capacitors at an eligible site.

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[2] The nomination form template can be found on the ESS website at: www.ess.nsw.gov.au/Methods_for_calculating_energy_savings/Power_Factor_Correction

The implementation date is the date the power factor correction capacitors are installed. Energy savings can only be created where the implementation date is after the date the energy saver is accredited as an ACP.[3]

## 3.4 Site requirements

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

### 3.4.1 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 Installations Rules of New South Wales.

### 3.4.2 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[4] provide further clarification on whether a switchboard is considered a main switchboard.

## 3.5 Equipment requirements

### 3.5.1 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[5] compensators (SVCs), as they use capacitors to provide their reactive power, and
- static synchronous compensators (STATCOMs), as they also employ capacitors.

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3 The ESS website provides information on applying to become an Accredited Certificate Provider. www.ess.nsw.gov.au/How_to_apply_for_accreditation.

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

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

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

### 3.5.2 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.[6]

### 3.5.3 New capacitors

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

## 3.6 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 requirement to provide power factor correction.

## 3.7 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.[7]

# 4 Calculation of energy savings

The energy savings resulting from the installation of power factor correction capacitors are calculated in accordance with equations 13 and 14 of the ESS Rule as outlined below (Appendix A of this guide set out equations 13 and 14).

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

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

## 4.1 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.

### 4.1.1 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.

### 4.1.2 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.

Table A19 of the ESS Rule (see 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 three 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,
- checking the local government area the site is in, or
- using the Australian Energy Regulator's (AER) 'Energy Made Easy' service.

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 *Electricity Supply Act 1995* specifies the DNSP for each distribution district.

**Determining the DNSP from the AER tool**

The AER maintains an online electricity comparison tool[8] which can identify the DNSP responsible for the supply of electricity to the site, from the site's postcode. The DNSP for the postal area is listed on the summary page under 'Distributor'.[9]

### 4.1.3 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.

### 4.1.4 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.

### 4.1.5 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[10]) of the installed capacitors.

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8 http://www.energymadeeasy.gov.au

9 The AER service is unable to identify the DNSP where a postcode is serviced by multiple DNSPs.

10 "kilovolt amperes reactive", which is reactive power.

## 4.2 Energy savings

The energy savings, which are used to create ESCs, must be calculated in accordance with equation 13 of the ESS Rule. The energy savings are calculated as the power savings over the expected lifetime of the power factor correction capacitors. For the purposes of the Power Factor Correction Energy Savings Formula Method, this lifetime is taken to be 10 years.

## 4.3 Calculation tool

The evidence package for this method outlines the evidence needed for an ACP to support the calculation of energy savings and the creation of ESCs.

Section 1 of the evidence package includes a calculation tool that calculates the energy savings in accordance with equations 13 and 14, and Table A19 of the ESS Rule.

Alternatively, you may develop your own calculation tool or use a tool provided by another party. If you wish to use an alternative calculation tool, the calculations and outputs from the tool may be subject to audit.

It is recommended that, where possible, you use the calculation tool provided by the Scheme Administrator to minimise your audit costs.

## 4.4 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.

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

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.

# 5 Creating Energy Savings Certificates

The Evidence Manual Power Factor Correction Energy Savings Formula (evidence manual) provides instructions on how to create ESCs from eligible power factor correction installations and details the requirements for keeping records to verify the energy savings achieved.

The **evidence package** that accompanies the **evidence manual** is available on the ESS website.[11]

# 6 Applying for accreditation

A completed application tailored to this energy savings method is required for a person to become an ACP and create ESCs under this method.

An application has multiple parts, which are explained in the **Application Guide**.[12] As a minimum, you will have to provide:

- Application Form: Part A - General Details, available at www.ess.nsw.gov.au/How_to_apply_for_accreditation
- Application Form: Part B - Method Details, available at http://www.ess.nsw.gov.au/Methods_for_calculating_energy_savings/Power_Factor_Correction/Apply_for_Power_Factor_Correction

For a full explanation of the application process, please read the Application Guide.[13]

# 7 Glossary

**Table 7.1 Power Factor Correction Energy Savings Formula definitions**

| 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 |

11 www.ess.nsw.gov.au/Methods_for_calculating_energy_savings/Power_Factor_Correction.
12 www.ess.nsw.gov.au/How_to_apply_for_accreditation.
13 The Application Guide can be found at www.ess.nsw.gov.au/How_to_apply_for_accreditation

| | |
|---|---|
| ESS Rule | Energy Savings Scheme Rule of 2009 |
| Implementation | Refer to section 3.3 of this guide |
| Implementation Date | Refer to section 3.3 of this guide |
| kV | Kilovolt |
| kvar | Kilovolt-amperes reactive |
| kW | Kilowatt |
| kWh | Kilowatt-hour |
| PF | Power Factor |
| PFC | Power Factor Correction |
| Purchaser | Refer to section 3.2 of this guide |
| RESA | Recognised Energy Saving Activity |
| MWh | Megawatt-hour |

# Appendices

# A Activity Definitions and Equipment Requirements

## A.1 Equations and inputs to calculations

### Equation 13

For each Implementation:

**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 equation 14 of the ESS Rule (see below).
- Annual operating hours, in hours/year, is the number of hours per year that the site is operating and equals 1750.
- Site Life, in years, is the expected remaining lifetime of the site and the capacitors and equals 10 years.

### Equation 14

**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, as detailed in Table A19 of the ESS Rule (see Appendix B of this guide).
- 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.

# B Table from the ESS Rule

**Table A19: Distribution Loss Factors (DLF) for losses between the subtransmission network and low voltage connection points**

| Distribution Network Service Provider | Distribution District | DLF |
|---|---|---|
| Endeavour Energy | Endeavour Energy | 1.054 |
| Essential Energy | Essential Energy | 1.074 |
| AusGrid | AusGrid | 1.043 |