



THE UNIVERSITY
OF QUEENSLAND
AUSTRALIA

CREATE CHANGE

Smart inverters in Australia

Control laws

Single-phase inverters control Q in the phase they are connected to

Based on they see across the terminals

Three-phase inverters take the average voltage magnitude of the 3 phases they see, which would be phase-to-phase typically

Three-phase inverters without neutral are less expensive than with neutral

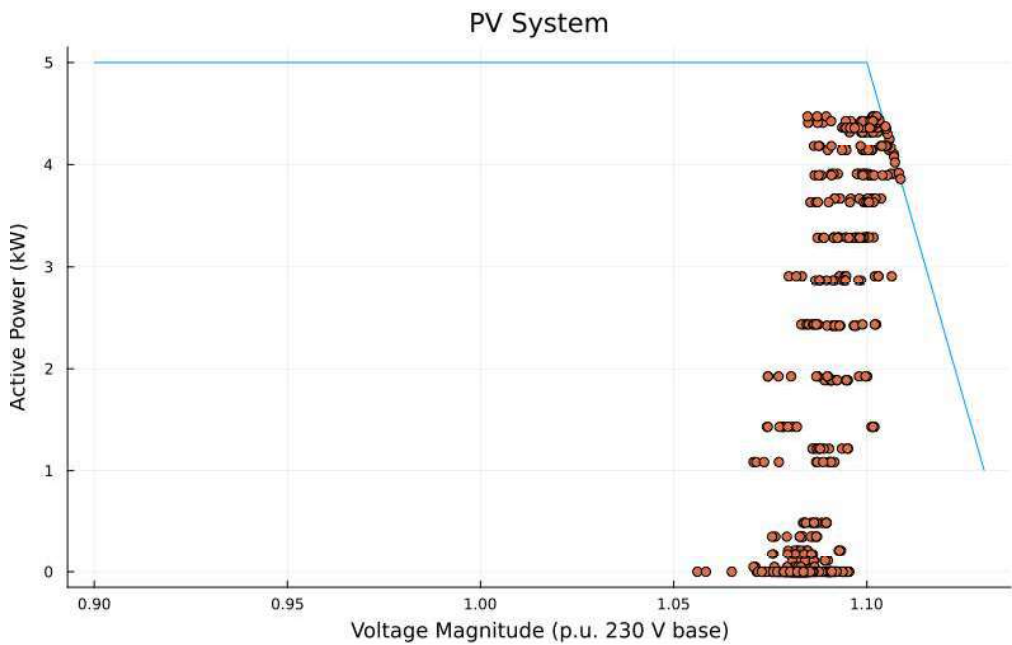
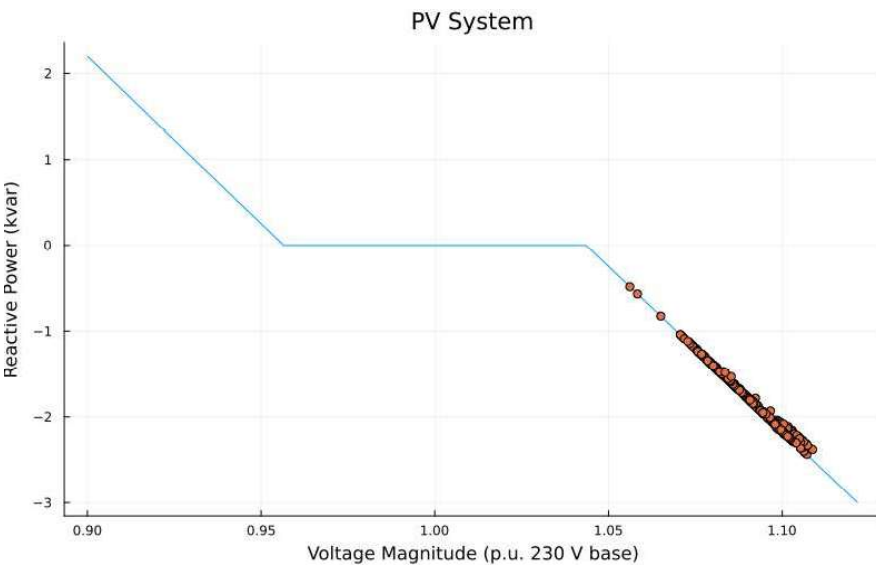
Could be improved, doesn't allow room for unbalance compensation

Volt-var and Volt-Watt Control Variations.

Variation	Control
Phase-to-neutral	$P_{g,an} = f^{VW}(U_{g,an}^{\text{mag}})$ $Q_{g,an} = f^{VV}(U_{g,an}^{\text{mag}})$
Phase-to-phase	$P_{g,ab} = f^{VW}(U_{g,ab}^{\text{mag}}/\sqrt{3})$ $Q_{g,ab} = f^{VV}(U_{g,ab}^{\text{mag}}/\sqrt{3})$
Phase-to-phase averaged	$P_{g,ab} = P_{g,bc} = P_{g,ca} = f^{VW}\left(\frac{U_{g,ab}^{\text{mag}} + U_{g,bc}^{\text{mag}} + U_{g,ca}^{\text{mag}}}{3\sqrt{3}}\right)$ $Q_{g,ab} = Q_{g,bc} = Q_{g,ca} = f^{VV}\left(\frac{U_{g,ab}^{\text{mag}} + U_{g,bc}^{\text{mag}} + U_{g,ca}^{\text{mag}}}{3\sqrt{3}}\right)$
Phase-to-ground averaged	$P_{g,a} = P_{g,b} = P_{g,c} = f^{VW}\left(\frac{U_{g,a}^{\text{mag}} + U_{g,b}^{\text{mag}} + U_{g,c}^{\text{mag}}}{3}\right)$ $Q_{g,a} = Q_{g,b} = Q_{g,c} = f^{VV}\left(\frac{U_{g,a}^{\text{mag}} + U_{g,b}^{\text{mag}} + U_{g,c}^{\text{mag}}}{3}\right)$
Phase-to-neutral averaged	$P_{g,an} = P_{g,bn} = P_{g,cn} = f^{VW}\left(\frac{U_{g,an}^{\text{mag}} + U_{g,bn}^{\text{mag}} + U_{g,cn}^{\text{mag}}}{3}\right)$ $Q_{g,an} = Q_{g,bn} = Q_{g,cn} = f^{VV}\left(\frac{U_{g,an}^{\text{mag}} + U_{g,bn}^{\text{mag}} + U_{g,cn}^{\text{mag}}}{3}\right)$
Phase-to-ground	$P_{g,a} = f^{VW}(U_{g,a}^{\text{mag}})$ $Q_{g,a} = f^{VV}(U_{g,a}^{\text{mag}})$

AS/NZS4777.2:2020 is a new standard for small-scale inverters that became mandatory for all new installations in Australia on 18 December 2021.

Volt-var Watt



Volt-var *on* the curve
Volt-Watt below or on the curve

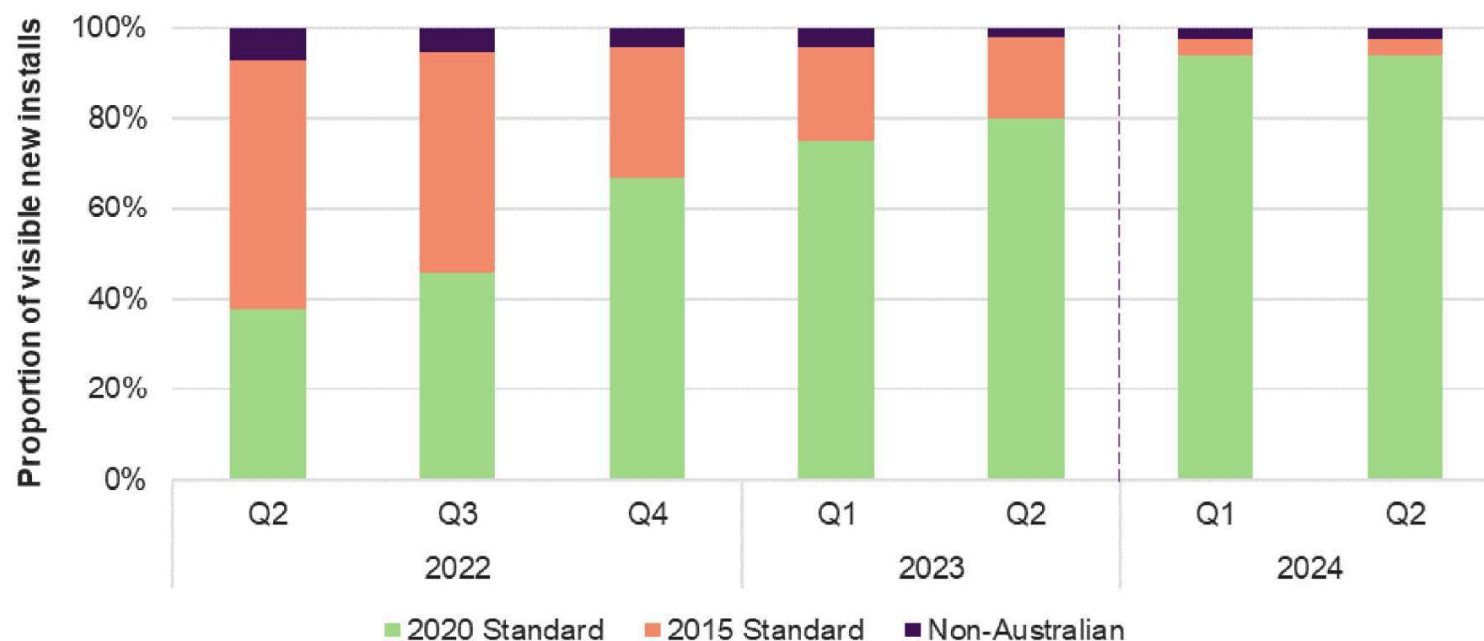
Volt-var/Watt is mandatory in Australia AS4777.2

- Historically, PV systems operated at constant power factor (0.95, 0.98 lagging), often unity power factor
 - Lagging brings down the voltage
- Volt-var/Watt improves network voltage
 - End-users effectively contribute to voltage management
 - Implemented as control loops in standard PV inverters
 - Settings (break-points) should not be modifiable by user, but follow the standard
- Continuous, proportional behavior
 - In the past, there was mandatory disconnect on/off

Postpones network investment if most (all) systems have VV/VW functionality with the same settings

Compliance

Figure 1 Estimates of quarterly compliance to the AS/NZS4777.2:2020 grid code



<https://www.aemo.com.au/initiatives/major-programs/nem-distributed-energy-resources-der-program/standards-and-connections/compliance-of-der-with-technical-settings>

“2025 Update: Compliance of DER with Technical Settings”

Note: the OEMs included in the aggregation vary by quarter, based on which OEMs responded to the data request. Market coverage associated with these OEMs varies from 52% to 95%. Compliance estimates in this plot are scaled by OEM market share in that calendar year and assume that the visible portion of an OEM’s fleet is representative of their entire fleet.