Enhancing the Spot Market to Attract Investments to Renewables

Deliverable 3: Assessment of WESM Price Patterns and Mitigating Measures

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by

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Disclaimer

Acronyms

ACCC	Australian Consumer Competition Council
AE	Independent Electricity Market Operation of Philippines
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AESO	Alberta Energy System Operator
ANEM	Australian National Electricity Market
APC	Administered Price Cap
APP	Administered Price Period
ASEAN	Association of Southeast Asian Nations
BAU	Business As Usual
CfD	Contract for Difference
CPT	Cumulative Price Threshold
DOE	Department of Energy
ECA	Economic Consulting Associates Ltd.
ECO	Enforcement and Compliance Office – PEMC
ERC	Energy Regulatory Commission
ETP	Energy Transition Partnership
FIT	Feed-in Tariff
GEAP	Green Energy Auction Program (Philippines)
GWAP	Generator Weighted Average Price
IES	Intelligent Energy Systems
IESO	Ontario Independent Electricity System Operator
ISO	International Organisation for Standardization
IT	Information Technology
LMP	Locational Marginal Price
LOLE	Loss of Load Expectation
LRMC	Long-Run Marginal Cost
MPC	Market Price Cap
MPF	Market Price Floor
NCL	Nel Consulting Limited
NDA	Non-Disclosure Agreement
NEMS	National Electricity Market of Singapore
NZEM	New Zealand Electricity Market
PEMC	Philippines Electricity Market Corporation
PJM	Pennsylvania New Jersey Maryland
PPC	Primary Price Cap
RBMF	Results Based Monitoring Framework
RE	Renewable Energy
REC	Renewable Energy Certificate
RFP	Request for Proposal
RPS	Renewable Portfolio Standards

SDG	Sustainable Development Goal
SO	Strategic Outcome
SPC / SEC	Secondary Price Cap
SQL	Structured Query Language
SRMC	Short-Run Marginal Cost
TWG	Technical Working group
UNOPS	United Nations Office for Project Services
VBA	Visual Basic for Application
VRE	Variable Renewable Energy
WESM	Philippines Wholesale Electricity Market

Definition of Terms

Energy-only Market – an electricity market where energy is the sole commodity traded, excluding ancillary services.

Generator Weighted Average Price (GWAP) – in the context of WESM, refers to the time-weighted average of generator nodal energy prices.

Indexed – refers to the any quantity being adjusted using a benchmark indicator as reference.

Locational Marginal Price (LMP) – in the context of WESM, refers to the price of supplying electricity determined each period for specified node or location in the power system to reflect the cost of transmission line loss or congestion.

Loss of Load Expectation (LOLE) – metric, expressed in units of time, used to quantify the likelihood of the power system's inability to meet the supply the demand in a specified period.

Reliability – the ability of the power system to adequately and consistently meet the electricity demand.

Table of Contents

1 Executive Summary

The Philippine Wholesale Electricity Spot Market (WESM) has greatly evolved since it began its commercial operations in 2006. Due to the sustained high prices in the past, policies including Offer Price Caps, Offer Price Floor, and Secondary Price Cap have been put in place to control prices while setting a competitive environment among the market participants. These price settings and other WESM rules ensure generator revenue adequacy, promote efficient investment, and minimise end-user costs, which are the core objectives of the WESM. These price settings were derived from the operational costs, capital expenditures, and investment costs at the time they were implemented.

The level of the market price cap is still imposed in the present market and has not been adjusted since 2015. The cost structure of the WESM is likely to shift with higher RE generation targets. Increased volatility is expected from rising intermittent generation resources, leading to a growing need for peaking or firming generation options over time. With this, it is necessary that the methodology of setting the price caps be reviewed, and if required, updated to reflect the current economic landscape and thereby encourage investments in the RE generation.

This report corresponds to Deliverable 3 of the "Enhancing the Spot Market to Attract Investments to Renewables" project and covers the following areas:

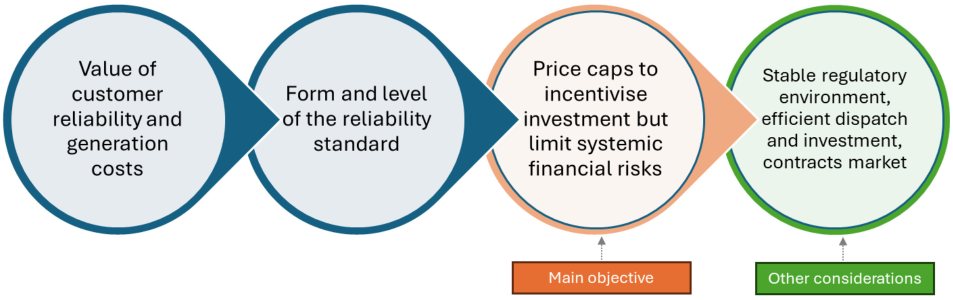
- An international review is carried out to canvas a variety of approaches to the general problem of market price mitigation measures.
- Analysis of WESM price patterns to identify frequency, periods and drivers of sustained high prices prompting the imposition of price caps.

A review of the Market Price Cap and Secondary Price Cap and its impact on generator revenues in the broader context of cost recovery.

International Review of Price Mitigation Measures

The design of various markets aims for efficient dispatch, investment, and end-user costs. Price mitigation measures comprise one of many elements that forms an electricity market. However, the determination of price caps or mitigation measures across many of the markets assessed lacks a robust framework that explicitly trades off end-user costs and reliability value. In considering any future reform or changes to the WESM price caps, an explicit reliability standard should be set which in turn will drive the overall price caps to ensure revenue adequacy.

Figure 1 Price caps in the context of reliability and efficient outcomes



The current price cap settings in the WESM have been established based on a traditional energy mix and have not been updated to align with the evolving requirements of the energy transition. While the design of various markets prioritises efficient dispatch, investment, and end-user costs, the WESM lacks a robust framework to assess the trade-off between end-user costs and the value of reliability in determining price caps or other price mitigation measures. Other findings include:

- In the WESM, primary price caps are applied to final settlement prices; however, spot prices often exceed these primary offer caps. In markets with low primary price caps, concerns arise regarding the efficiency of dispatch, particularly when the price cap falls below the demand response threshold.
- Secondary price caps are implemented to limit sustained high price exposure, which can threaten market stability and integrity. The criteria for triggering secondary price caps (such as cumulative price thresholds) and setting their levels in the WESM is unclear. In Australia, considerations include incentivising long-duration storage, the impact on the hedging and contracting markets, and financial integrity.
- Market price floors are generally set at zero, unless there is a need to enable the underlying generation fleet to manage unit commitment operations. The level of renewable energy generation within a market may influence this setting.
- The frequency of reviews to assess the adequacy of price settings or price mitigation measures varies across jurisdictions. While frequent monitoring of price volatility is ideal, it is important to consider the potential investment risks associated with ad-hoc changes to underlying price settings, which can undermine stability.
- Most jurisdictions currently do not explicitly account for the role of price settings in incentivising broader energy transition requirements. However, this is likely to be suboptimal due to changing revenue recovery dynamics of VRE and firming technologies relative to traditional energy mixes.

WESM Price Trends

Throughout the 10-year period, high demand and high outages were the primary drivers of high market prices in the WESM. Various policies, including price caps, have been put in place to control prices while setting a competitive environment among the market participants. However, the frequency of triggering the Primary Price Cap (PPC) is high, and prices can substantially exceed 32,000 Php/MWh. Similarly, the frequency of Secondary Price Cap (SPC) triggers has notably increased due to the reduction of the Cumulative Price Threshold (CPT) to three days. This potentially undermines generation investments as the caps would most likely set the price instead of the market.

While the offer price floor does not require revision at this time, conditions should be closely monitored as VRE penetration grows. The impact of high prices driven by low renewable energy generation is expected to rise with increasing VRE penetration. Therefore, policies regarding price caps should not only incentivise investments in renewable energy generators but also support the development of firming generation technologies, such as battery energy storage systems (BESS), peaking gas plants, and pumped storage.

Price Mitigation Revenue Impacts

Potential reductions in revenue due to amendments to the primary and secondary price caps have a marginal impact of 10% on the gross revenues for solar and wind resources. These resources have historically recovered their estimated fixed costs based solely on revenues excluding PPC and SPC. In contrast, non-renewable resources are more affected, as they generate approximately 12% of their gross revenues during price mitigation periods and would comprise an even larger share of net revenues after accounting for fuel costs. Changes to price mitigation measures could significantly impact the financial feasibility of these non-renewable generation types.

Although spot revenues from non-PPC and non-SPC intervals over the past 5-years have delivered revenue adequacy for solar and wind plants, the historical outcomes should be treated with caution and price settings should be forward-looking to account for the potential persistence of high fuel prices supporting base revenues and the impact of increased VRE penetration on revenues. As such, price settings should be forward-looking to account for the potential persistence of high fuel prices supporting base revenues and the impact of increased VRE penetration on revenues.

As the share of fixed costs within the WESM cost structure increases, this trend is expected to continue with rising RE penetration. The Primary Price Cap and SEC are crucial for fixed cost recovery in WESM, given that it operates as an energy-only market.

In terms, of the potential changes to the PPC and SEC, spot revenue losses from capping settlement prices to the primary price cap would likely be more than offset by the proposed change to the Secondary Price Cap.

Conclusion and Further Assessments

The Offer Price Cap, Offer Price Floor, and Secondary Price Cap have been put in place to control market prices while setting a competitive environment among the market participants in the WESM. However, these values were benchmarked on the costs related to operating the most expensive plant during the time they were implemented. The price caps have not been adjusted since then. The power sector outlook has drastically changed since the implementation of these caps and to achieve the target Renewable Energy mix in the future, there is a need review the existing price caps and price mitigation measures.

The following summarises the key points related to establishing transparent price settings in the broader context of reliability in the WESM:

1. **Establishing the Value of Customer Reliability (VCR)**: The VCR determines how much consumers, including residential, commercial, and industrial sectors, are willing to pay for reliability. This calculation, which affects price settings and tariffs, must be based on a methodology that is rigorously consulted on and quality-assured.
2. **Setting the Reliability Standard**: The reliability standard, currently defined as an average Loss of Load Expectation in the WESM Grid Code, serves as a benchmark for assessing reliability levels. Any reforms should align the standard with end-user preferences, ensuring thorough stakeholder consultation.
3. **Modelling the Reliability Standard**: After establishing the VCR and form of the reliability standard, detailed modelling is necessary to balance the cost of unserved energy against the costs of additional generation and transmission investments. The efficient or appropriate level of the reliability standard is where these system costs are minimised.
4. **Identifying Reliability New Entrants**: Market simulations are used to determine the reliability gap over the forecast horizon and identify the least-cost reliability new entrant needed to meet the standard.
5. **Determining Price Settings**: The price settings, including the primary and secondary price caps, must be structured to ensure that new reliability entrants can recover their costs while meeting the reliability standard. This involves modelling to account for revenue variability and balancing different combinations of price cap settings to achieve revenue adequacy.
6. **Incorporating Considerations into WESM Rules**: These considerations should be integrated into the WESM Rules to support transparent, reliable mechanisms for sustainable investment. Regular reviews should be conducted to update price settings and assumptions like the VCR, ensuring alignment with changing supply costs.

2 Introduction

1.1 Project Background

Intelligent Energy Systems Pty Ltd (IES), Economic Consulting Associates Ltd (ECA), & Nel Consulting Limited (NCL) have been selected by UNOPS to carry out the project titled "Enhancing the Spot Market to Attract Investments to Renewables". The project is implemented under the UNOPS Southeast Asia Energy Transition Partnership.

ETP has four strategic outcomes: (SO-1) policy alignment with climate commitments, (SO-2) de-risking investments on energy efficiency and renewable energy, (SO-3) extending smart grids, and (SO-4) knowledge and awareness building. The project is focused on contributing towards SO-2 and SO-4 to facilitate increasing participation of renewable energy resources in the Philippines Wholesale Electricity Spot Market (WESM) by reviewing price mitigation measures and methodologies and analysing the barriers and investment risks to RE deployment in the Philippines and energy self-sufficiency targets.

The expected long-term outcomes from this project are:

- Increase uptake of renewables in Philippines power system.
- Enhance understanding of opportunities for RE generators in the WESM to encourage greater level of investment in RE.
- Improve price mitigation measures to encourage investments into RE generation, increase market participation, and enhance market competition which lead to lower electricity tariffs.
- Strengthened capability of Philippine Electricity Market Corporation (PEMC) and Independent Electricity Market Operation of the Philippines (IEMOP) to monitor and analyse market and price trends, and update price mitigating measures in the future.

1.2 ETP Role in Supporting the Energy Sector Transition in the Philippines

The Southeast Asia Energy Transition Partnership (ETP) unites philanthropies and governments to collaborate with regional partners. ETP supports the switch to contemporary energy systems that can guarantee environmental sustainability and climate action, energy security, and economic prosperity. The ETP is currently focusing its support to the countries of Indonesia, Vietnam, and the Philippines to support in achieving the Paris Climate Agreement targets and in alignment with the UN Sustainable Development Goals (SDGs). Four interconnected strategic engagement pillars that are well matched to overcome the obstacles to energy transition form the foundation of ETP's approach. These include:

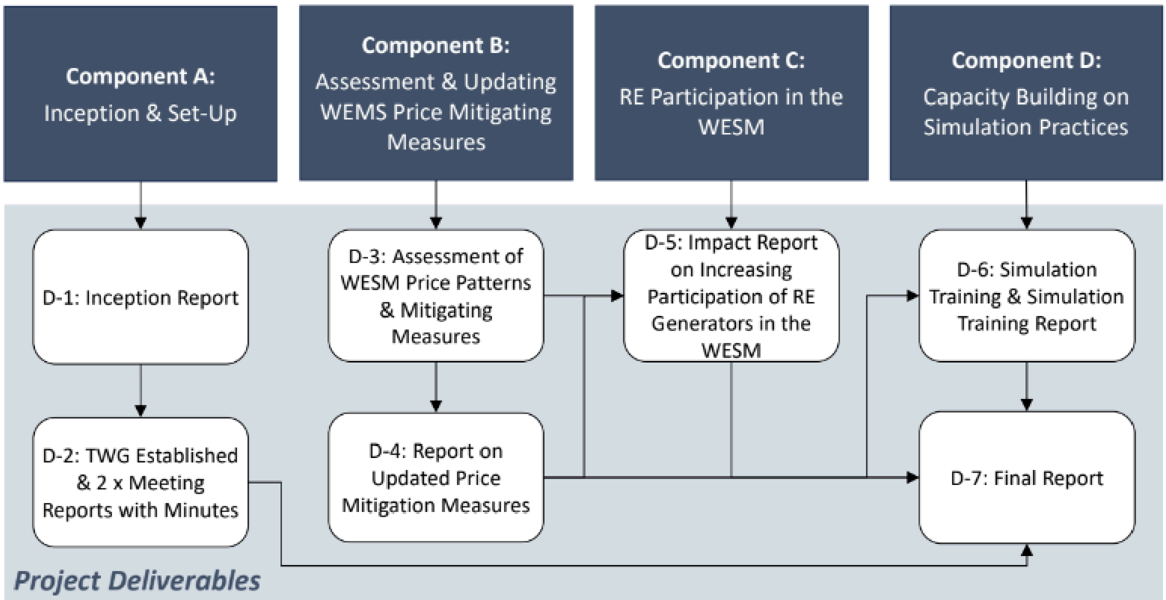
- Aligning policies with climate commitments,
- Reducing the risk associated with investments in renewable energy and energy efficiency,
- Expanding smart grids, and
- Expanding knowledge and awareness building.

1.3 Scope of Work

The project will address the market barriers to renewable energy investments by assessing and updating the methodologies for setting price-mitigating measures and recommending new cap values at balanced levels that will attract investments and at the same time protect consumers from high tariffs. The government has acknowledged that the current, outdated, and low-price caps discourage investments in peaking generators leading to heavy reliance on aging fossil-based plants. The project will also analyse the opportunities for more renewables in the spot market and the risks to RE investments.

To achieve the intended outcomes and objectives, the project has been structured into four components: (1) Component A: Assessment of WESM Price Mitigating Measures, (2) Component B: Updating Price Mitigating Measures, (3) Component C: Analysis of RE Participation in the WESM, and (4) Component D: Capacity Building. The components and key deliverables / outputs for each component are illustrated in the following Figure 2:

Figure 2 Components and Deliverables



This report corresponds to Deliverable 3 and covers the international review of various electricity markets and the assessment of the WESM Spot Market price patterns and price mitigation measures. An international review is carried out to canvas a variety of approaches to the general problem of market price mitigation measures. The analysis of WESM Price patterns is then carried out to identify periods of sustained high prices which prompted the imposition of price caps. Finally, a review of WESM Price Mitigation Measures will address the contributions of the price caps to generator revenues.

1.4 Report Structure

The report for Deliverable 3 is structured as follows:

- Section 3 provides the Internation Review of Price Caps and Price Mitigation Measures across various Electricity Markets.

- Section 3.9 provides the Assessment of WESM Price Trends
- Section 5 provides the Review of WESM Price Mitigation Measures.

The basis of figures quoted in this report, unless otherwise stated, is listed in Table 1.

Table 1 Reporting basis

Reference	Basis
Analysis horizon	4 January 2014 to 25 April 2024[1]
Capacity and generation	As generated
Demand	Operational, sent out basis
Currency and basis	Nominal Php
Average prices	Time-weighted
Year	Calendar year basis, Jan to Dec. 2024 covers the period 1 Jan 2024 to 25 Apr 2024.

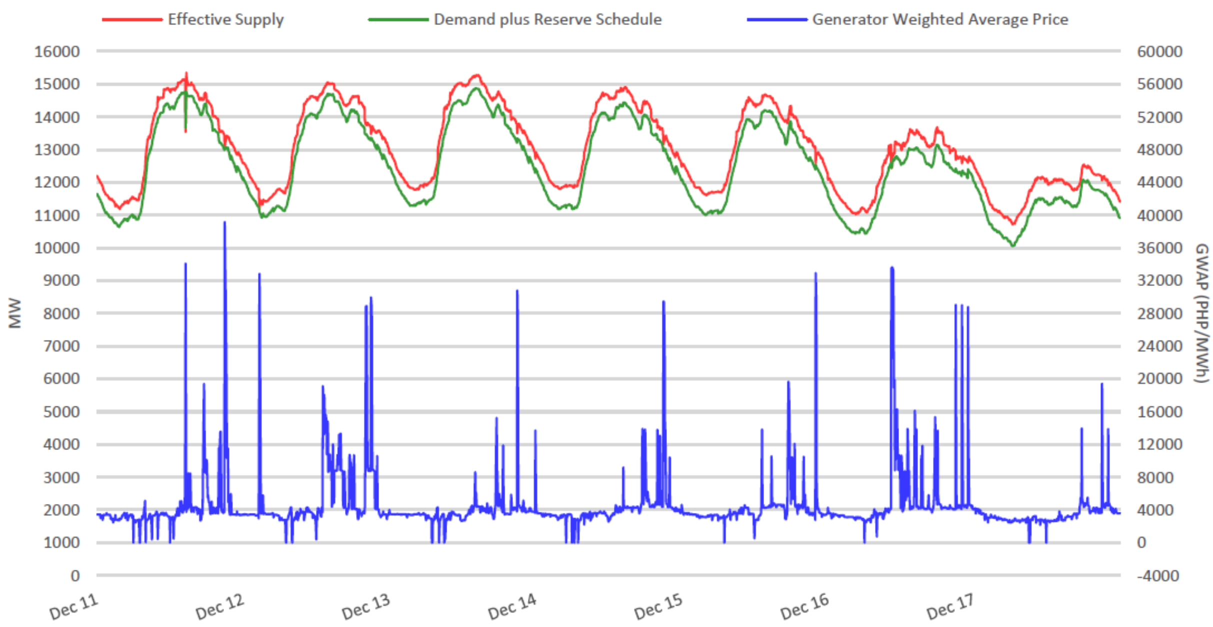
[1] Covers the period from which the primary price cap was reduced to 32,000 Php/MWh.

2 International Review of Price Mitigation Measures in the Wholesale Electricity Markets

2.1 Price Controls in Power Markets

Electricity spot market prices such as the WESM are notoriously volatile in the short-term as compared to other financial and commodity markets primarily because of limited options for electricity to be stored and inelastic electricity demand. See for example Figure 3, WESM spot prices[2].

Figure 3 WESM Price Volatility Over 11-17 December 2023



Pricing events can arise from a range of factors including (1) short-term supply and demand situation, (2) available generation plant and their characteristics (level of flexibility), (3) fuel prices and availability – including hydro storage levels, (4) characteristics of demand – flat and predictable vs. peaky and volatile, (5) industry structure – in particular the number of active sellers and buyers in the spot market, and (6) network capability and transmission constraints.

On one hand, in wholesale electricity markets that are designed as energy-only markets[3] such as the WESM or the Australian National Electricity Market (ANEM), high prices send a signal to prospective developers to build new generation and enter the power market, while on the other hand, high prices present risks to electricity purchasers and consumers. If there are sustained periods of high prices, or short periods of time with very high prices, then in the worst case, market participants may face extreme exposure to high prices threatening their financial viability.

Consequently, a suite of measures is deployed in wholesale markets – such as the Philippines, Australia, Singapore, New Zealand, and many others, that seek to find the right balance and

[2] Source: IEMOP, "Weekly Market Watch" source: https://www.wesm.ph/market-outcomes/market-watch, 20 December 2023.
[3] Energy-only markets do not explicitly implement capacity markets / capacity payment mechanisms.

trade-off between competing objectives: one is to ensure that spot prices will be high enough to create the incentive for investment and deliver a reliable power system, vs. imposing low caps or secondary price caps to limit exposure to volatile spot market prices.

A summary of measures in various power markets is covered in the following sub-sections to illustrate the suite of measures typically deployed in such markets that have many similarities in their design features to the WESM. The focus of the review is energy and ancillary services, and not capacity. The assessment covers the following areas summarised in Table 2.

Table 2 List of mitigation measures reviewed

Mitigation measure	Description
Capacity market	Capacity payments provides a more stable and predictable revenue stream for generators, reducing the reliance on scarcity pricing and higher price caps relative to an energy-only market.
Reliability standard	The form and level of reliability. The form refers to the metric such as percentage of demand, or Loss of Load Expectation, and the level refers to the set quantity, such as 0.002% of demand.
Competition law	Limits market share to ensure there are multiple sellers (generators) and/or buyers (retailers). Incentivises the industry to have multiple buyers and sellers to promote competition and efficient outcomes.
Market price cap	A price setting that caps the highest spot price that is allowed for a single dispatch period and typically is set to a level that will create an incentive for sufficient capacity to enter the market. This is also referred to as a Primary Price Cap (PPC).
Secondary price cap	A price setting that provides protection to consumers against sustained high prices.
Market price floor	A price setting that represents the lowest possible settlement price and is set to a level that is usually negative to create an incentive to avoid over-generation.
Equivalent caps and floors for market reserves	Provides similar protections as the energy price caps and floor.
Equivalent caps and floors for generator offers	Provides an additional layer of price control ensuring that the market price caps and floors are enforced within the bids and offers of market participants.[4]
Compliance monitoring	Ensures market participants are operating in line with the market rules.
Market monitoring measures	Routine monitoring of anti-competitive behaviour of market participants that would not be readily detectable via a compliance monitoring regime.
Considerations for end-user costs, efficient investment and energy transition requirements	Whether or not the price settings (mainly price caps) consider end-user costs, efficient investment and encourage renewable energy generation.

[4] Bids refer to potential demand response options.

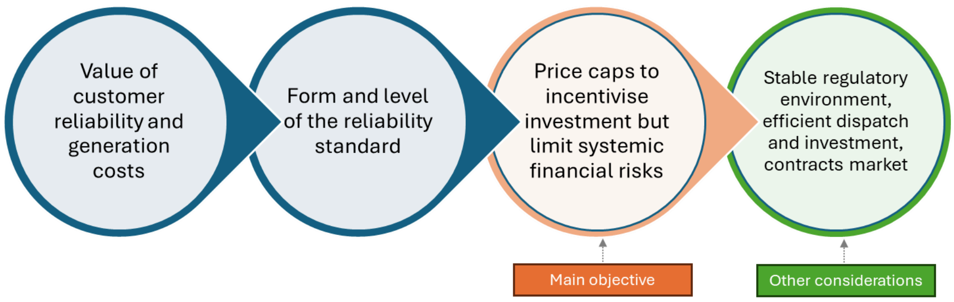
For wholesale electricity markets to operate efficiently and effectively the suite of measures such as the above must all work together and in a coordinated manner. Furthermore, as the underlying technology mix in such markets continues to evolve or as markets continue to change or be subject to new conditions such as rapid rises in commodity prices, they need to also be continuously reviewed and updated to ensure they continue to provide the right balance between:

- Reliability and investment and its cross-section with the value of reliability,
- Allow for efficient price signals but at the same time limit systemic financial risks, and
- Safeguarding against anti-competitive behaviour.

A key concept that is widely referred to when designing electricity markets and setting pricing parameters is the value of customer reliability. This is the value that consumers would be willing to pay to avoid instances of load shedding, and generally feeds into regulatory frameworks which set out the appropriate levels of reliability in the system. A sufficiently high value of customer reliability means customers are willing to pay a lot to avoid unserved energy which corresponds to a very reliable system.

The relationship between these factors, and the general order in which they should be set, are illustrated in Figure 4, i.e., in a true cost-reflective market, the trade-off between the value placed on reliability by consumers and supply costs should determine the reliability standard which then drives the level of the primary price cap needed to meet the target. Additional market or policy overlays, such as secondary caps and competition laws, are also applied to ensure the financial stability and efficient operations of well-functioning electricity markets.

Figure 4 Price caps in the context of reliability and efficient outcomes

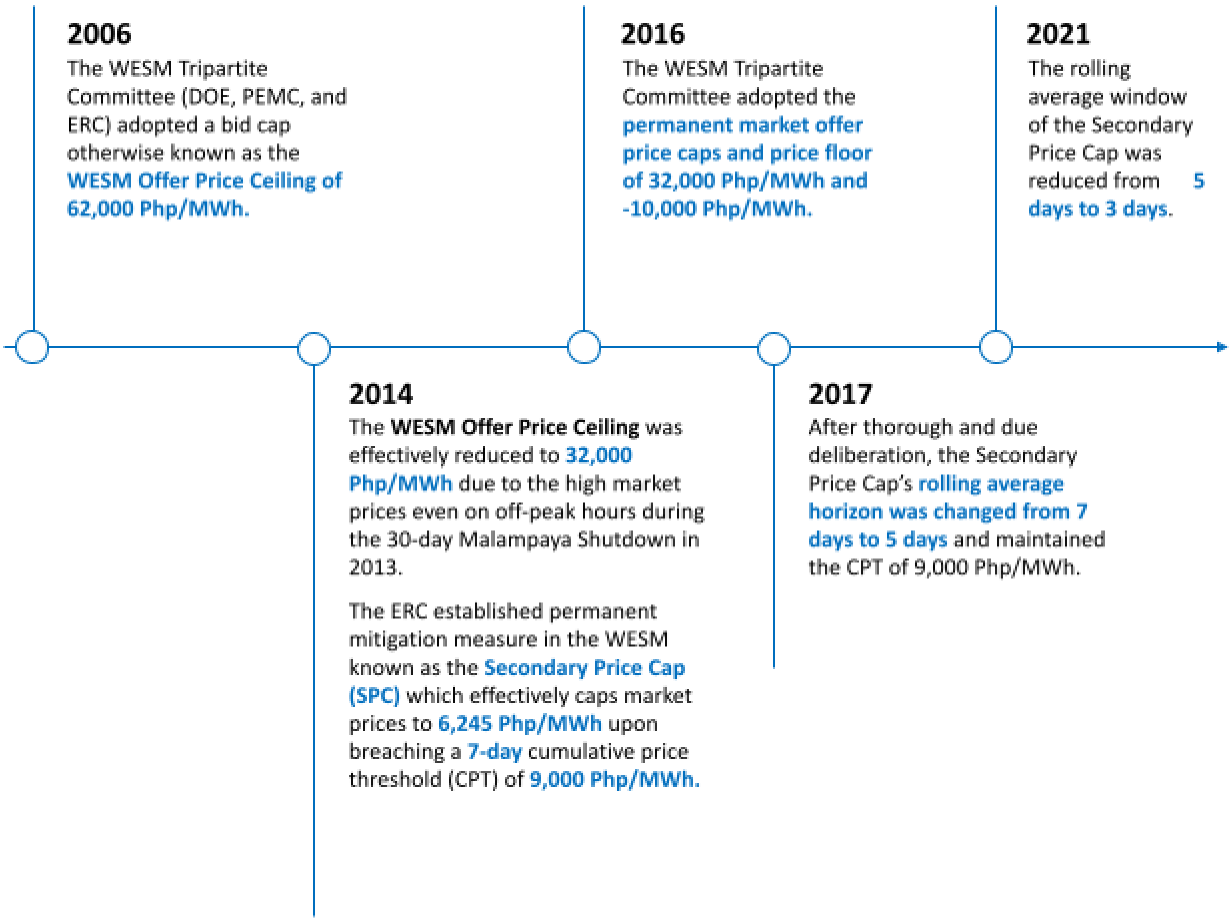


A contract market for hedging helps mitigate price volatility in an electricity market by allowing market participants, such as generators and retailers, to lock in prices for future electricity delivery. This provides a financial safeguard against unpredictable price swings in the spot market and would support long-term investment in the WESM. While contract markets are out of scope, appropriate price cap levels are essential to incentivise effective hedging between participants. If price caps are set too low, they can undermine the incentive to hedge by reducing the effectiveness of risk management strategies.

2.2 Philippines WESM

The Wholesale Electricity Spot Market (WESM) is the centralised venue for trading electricity and reserves as commodities in the Philippines. It is a gross energy-only market where all energy is traded through the WESM regardless of the individual contract levels of the generators. WESM transactions follow a net settlement approach, applying market prices to all spot quantities or energy delivered by merchant generators without power supply agreements. Renewable energy sources are prioritised in the WESM dispatch and thus exposed to the volatility of market prices. Various policies have been put in place to control prices while setting a competitive environment among the market participants. The highlights of the amendments to these policies are illustrated in Figure 4.

Figure 5 Highlights of Amendments to Price Mitigation Measures in the WESM



On 09 June 2006, the WESM Tripartite Committee composed of the Department of Energy (DOE), the Energy Regulatory Commission (ERC), and the Philippine Electricity Market Corporation (PEMC) adopted a bid cap otherwise known as the WESM Offer Price Ceiling of 62,000 Php/MWh.

In 2013, the scheduled thirty-day Malampaya Turnaround required the use of more expensive alternate fuels for the natural gas-fired power plants. It was observed during this time that the market clearing prices were reaching the maximum offer cap even during off-peak hours when the electricity demand was low. As a result, the offer price ceiling was reduced to an interim level of 32,000 Php/MWh effective 04 January 2014.[5,6] In 2016, the WESM Tripartite Committee adopted the permanent market offer price caps and price floor of 32,000 Php/MWh and -10,000 Php/MWh.[7,8] The primary price cap in the WESM applies only to generator offers only and the actual settlement prices, which generally reflect congestion and other dispatch constraints, can lead to much higher prices.

To mitigate the sustained high prices during May and June in 2014, ERC implemented a Secondary Price Cap (SPC). This effectively caps high market prices to 6,245 Php/MWh when the rolling average of generator weighted-average prices (GWAP) over a 7-day period reaches a Cumulative Price Threshold (CPT) of 9,000 Php/MWh. The SPC has been set to recover the marginal cost of operating the most expensive plant during the time (diesel thermal plant).[9] With the intent to update the policy over the past years, ERC reduced the rolling average period to 5 days in 2017 and further reduced to 3 days in 2021.

Quoting from ETP, "The Philippine economy has drastically changed since the setting of the market price caps. The general opinion[10] is that the current price caps are too low that it discourages investments in peaking generators, such as solar and wind, leading to heavy reliance on base-load facilities or ageing plants that are costly to maintain[11]. Consequently, they lead to higher market prices. The low caps limit potential revenues and discourage investments, particularly in renewables which tend to have low operating costs but higher capital costs. Investors will be hesitant to commit to capital projects that may not be able to generate sufficient revenues. The low ceiling prices in the second round of the green energy auctions is one of the reasons identified for the low subscription, which highlights the sensitivity of investors to price signals. Renewable energy generation has priority in the merit-order table of the WESM and compensates based on the market clearing prices. They are price takers, where revenues are limited by the prevailing market prices."

The price caps in the energy-only WESM are pivotal in maintaining a balance between incentivising new generation investment through scarcity pricing, and providing price protections that may otherwise jeopardise the health and integrity of the market itself. The current WESM price mitigation measures relating to its primary and secondary price caps, however, have not been updated over the past 10 years.

Currently, there are proposed amendments to the secondary price cap mechanism. These include incorporating a supply-side margin approach and establishing a process for updating economic indices to reflect them in the SPC. In the supply-side margin approach mechanism, the supply margin is calculated based on the combined supply offers from bids and nominations from priority and must-dispatch RE over the total demand. The secondary price cap will then be triggered when the supply margin breaches lower than the threshold fifteen percent (15%). Moreover, the proposed amendments include provision for updating the base values of the secondary price caps. The proposed SPC is dynamic in a way that it is updated quarterly and reflects the current gas prices,

[5] WESM Tripartite Committee Joint Resolution No. 2. 17 December 2013. *Adjustments to the Wholesale Electricity Spot Market Offer Price Cap.*
[6] Philippine Electricity Market Corporation. Annual Market Assessment Report for 2014 Billing Period.
[7] ERC Resolution No. 14 Series of 2014. 5 August 2014. A Resolution Extending Further the Implementation of the Interim Mitigating Measure in the WESM.
[8] WESM Tripartite Committee Joint Resolution No. 3. 17 December 2015.
[9] ERC Resolution No. 20 Series of 2014. 5 August 2014. A Resolution Adopting and Establishing a Pre-emptive Mitigation Measure in the WESM.
[10] Jose A. E. O. (2023, Feb 1). ERC reviewing secondary price cap after DoE cites potential to unlock investment. Business World.
[11] Power Wrangler (2015). The Development and Review of the Methodology and Determination of the Levels of Offer Price Cap and Floor, and market Price Cap and Floor for Energy and Reserves [PowerPoint Presentation]. Development Academy of the Philippines

foreign exchange rates, and consumer price indices. The cumulative price threshold will also be revised accordingly from 9,000 Php/MWh to 13,657.38 Php/MWh which was derived from the 2022 WESM Prices. Finally, the rolling average period will be changed from 3 days to 7 days to normalise prices and always account for weekdays and weekends.

2.2.1 Reliability Standard

The System Security and Reliability Guidelines (Issue 2.0) for the WESM describes the general principles under which the WESM should operate, however, there are no quantitative measures for reliability. The Grid Code requires grid planning studies to consider the Loss of Load Probability (LOLP) and/or an Expected Energy Not Supplied (EENS), but no specific level is stated in the Grid Code

2.2.2 Competition Law

EPIRA of 2001 or Republic Act 9136 imposes competition limits on generation companies not being allow to "singly or in combination, own, operate or control more than thirty percent (30%) of the installed capacity of a grid and/or twenty-five percent (25%) of the national installed generating capacity."

2.2.3 Market Price Cap, And Any Secondary Cap

The market price cap and price floor that is referred to in the WESM is technically an offer cap and floor, i.e., there is no market price cap in the WESM. The final settlement price can be significantly higher due to other constraint costs in the system such as the cost of congestion.

There is, however, a secondary price cap that is applied upon triggering a cumulative price threshold based on average spot price of 9,000 Php/MWh over a rolling 3-day period. The secondary price cap is currently set to 6,245 Php/MWh. This is not indexed.

2.2.4 Market Price Floor

There is no market price floor, see above.

2.2.5 Equivalent Caps and Floors for Market Reserves

There is no market price floor or cap on reserve prices, see above.

2.2.6 Equivalent Caps and Floors for Generator Offers

There is an energy and reserve offer cap and floor of 32,000 Php/MWh and -10,000 Php/MWh, respectively.[12] The cap of 32,000 Php/MWh commenced in early Jan 2014. These values are not indexed.

2.2.7 Compliance And Market Monitoring Measures

The Enforcement and Compliance Office (ECO) of PEMC undertakes routine monitoring of market participants conformance to WESM Rules and Market Procedures – including must-offer rule compliance, and dispatch instruction compliance.

PEMC Market Surveillance Committee routinely monitors the WESM outcomes and reports against several defined market monitoring indices and other measures that are focused on detection of anti-competitive behaviour.

[12] Advisory 2024-01-001-SEC, DOE, Jan 2024.

2.2.8 Considerations For End-User Costs, Efficient Investment and Energy Transition Requirements

The WESM Rules state "The WESM Rules are intended to be complimentary with the Grid Code and Distribution Code, all of which are meant to ensure the development of an appropriate, equitable and transparent electricity market, along with a safe, reliable, and efficient operation of the power system." However, there is a disconnect between the current price caps, which have not been updated over the past 10 years and is unclear how these have been set to achieve the desired reliability outcomes and broader WESM objectives.

2.3 Australian National Electricity Market (ANEM)

The key design features of the ANEM design are similar to the WESM and include an energy-only gross pool, meaning there are no capacity payments, and generators are expected to recover their costs through the energy market. The Australian Energy Market Operator can also net out standardised bilateral contracts, although this is normally settled on a bilateral basis.[13] The dispatch interval is 5-min, and dispatch and prices are determined through a co-optimisation process incorporating energy and 12 other frequency control ancillary services. Spot prices are computed for a reference node for each region and is different to WESM's locational marginal pricing design. Like the WESM, settlement is entirely based on ex-ante outcomes.[14] The market design is decentralised, requiring generators to self-commit and manage any fuel or energy limitations through their offers.

In contrast, to the WESM, there is a transparent and rigorous framework that governs the targeted level of reliability which in turn drives the price settings in the market to incentive efficient investment and operations.

2.3.1 Reliability Standard

The reliability framework sets out both the form and level of the reliability standard. Although there is work underway to investigate the appropriateness of the current form of the standard, the current standard is for expected outcomes to not exceed 0.002% of annual demand in any given region. The level of the reliability standard is reviewed every 4 years to ensure adequacy in achieving the ANEM's electricity objectives which include efficient investment and consumer costs.

2.3.2 Competition Law

Australian Consumer Competition Council (ACCC) governs competition policy in Australia and is required to investigate market structure and assess whether a market is giving rise to competitive outcomes or not. In situations where competition is assessed to be negatively impacted the ACCC may take measures such as breaking up dominant players or monopolies or imposing additional price controls on the industry.

2.3.3 Market Price Cap, and Any Secondary Cap

The market price cap in the ANEM is set for every 4-year period and is currently 16,600 AUD/MWh (indexed over time). This is set to ensure revenue adequacy for the least cost new entrant portfolio to ensure reliability is consistent with the targeted reliability level. Similar to the WESM, there is a cumulative price threshold as part of a secondary price cap mechanism, which upon triggered, sets

[13] Bilateral contracts can be submitted to AEMO via the reallocation mechanism.
[14] Except for periods where intervention is required.

the maximum price spot prices can exceed. The cumulative price threshold is based on a 7-day lookback.

The most recent review saw the Australian Energy Market Commission significantly lift the price levels associated with the price caps in line with expected future conditions of the ANEM. The change is summarised in the table below. The parameters are firmly linked to reliability levels, accounting for other considerations in the reliability framework such as regulatory stability to minimise sudden shifts, efficient long-term investment across a range of technologies, and the impact to end-user tariffs. The cumulative price threshold and administered price is intended to protect all market participants under sustained high market prices but also balances out the risk of reducing incentives for hedging which can impede the efficient market operations.

Table 3 ANEM price cap changes

AUD (real, 2023)	Current period to Jun 2025	July 2025 to Jun 2028
Market price cap	$16,600/MWh	Increasing to $22,800/MWh
Cumulative price threshold	7.5 hours at market price cap	8.5 hours at market price cap
Administered price (not indexed)	$300/MWh	$600/MWh

Source: Australian Energy Market Commission.

2.3.4 Market Price Floor

There is a market price floor of -$1,000 AUD/MWh. The floor has not been adjusted since the inception of the ANEM but has been set to allow coal generators with significant unit commitment costs to offer manage its operations accordingly. This has been the primary driver of negative prices over recent years with the continued increase in renewable energy generation.

2.3.5 Equivalent Caps and Floors for Market Reserves

There are cap and floor prices for market reserves, 16,600 AUD/MWh and 0 AUD/MWh, respectively.

2.3.6 Equivalent Caps and Floors for Generator Offers

The cap and floor prices that applies for energy also apply to generator offers.

2.3.7 Compliance And Market Monitoring Measures

In addition to the broader competition laws in Australia, the National Electricity Rules has a requirement that generators cannot make false or misleading offers which can induce artificial price volatility at the detriment to the efficient clearing of the market.

Australian Energy Regulator (AER) responsible for routinely monitoring Australian NEM for exercise of market power and anti-competitive market behaviour. AER may conduct detailed investigations into instances (and institute court proceedings) where anti-competitive behaviour has been identified.[15]

AEMO regularly publish updates of the spot market and dynamics for individual major events and on a quarterly basis. The report focuses on general trends, volatility and its drivers. Where relevant, generator bidding dynamics are also covered as part of its market monitoring obligations.[16]

[15] Example: Australian Energy Regulator v Stanwell Corporation Limited [2011] FCA 991 (30 August 2011).
[16] Example: Quarterly Energy Dynamics Q1 2024, AEMO, April 2024.

2.3.8 Considerations for End-User Costs, Efficient Investment and Energy Transition Requirements

There is a clear reliability framework that sets out the how the reliability parameters are formed with respect to the overarching National Energy Objectives. The framework drives how the overall reliability standard is set which is turn drives the required settings (such as the market price cap) to meet the reliability targets. The review process carried out by the Australian Energy Market Commission balances out stakeholder requirements. Future capital costs and technical capabilities are explored in arriving at the least cost new entrant (portfolio) corresponding to long-term efficient investment, and the value of customer reliability is a significant input into the modelling process to identify the correct balance. The most recent change to the cumulative price threshold from 7.5 hours to 8.5 hours was driven by the need to incentivise long-term storage and its importance in supporting the ANEM's energy transition. Other considerations also include spot volatility, hedging and end-user tariff impacts, and the overall regulatory stability given the most recent change is a significant step-up in the price cap.

2.4 New Zealand Electricity Market (NZEM)

Like the WESM, NZEM is an energy-only market based on locational marginal pricing implemented using the scheduling, pricing and dispatch model. Generators make offers, and retailers and major industrial users make bids at more than 250 pricing nodes typically where the national grid connects to a local network. Five-minute indicative prices, often called "real-time prices", are calculated at the end of each five-minute period for every node[17].

Most hydropower resources are in the South Island which is connected to the North Island via an HVDC link. Because of New Zealand's significant reliance on hydro power sources, the main risk to reliability is a dry year. The main difference between the WESM and the NZEM, as far as reliability is concerned, is that NZEM has a significant dependence on hydro generation and is therefore energy and not capacity limited. Its reliability assessment therefore focuses on energy availability where the greatest risk is hydro storage.

2.4.1 Reliability Standard

The Electricity Authority (EA) website defines security of supply as "…the electricity industry providing appropriate electricity system capabilities (such as generation and transmission capacity) and storable fuel supplies (such as water, gas and coal) to maintain normal supply to consumers." The NZEM has security standards assumptions which EA is required to assess the system for planning purposes.[18] There are winter energy margins and winter capacity margins which is set in accordance with the total expected energy shortfall (0.06% of total demand) and expected hours of energy or reserve shortfall (22 hours per year) which corresponds to a benefit-cost ratio of additional investment. However, the relationship between the benefit-cost ratio is not required in setting the margins and there is no link between these planning margins and the market price cap.

2.4.2 Competition Law

The NZEM is governed by broader competition legislation in New Zealand's Commerce Act1986 which prohibits certain conduct and business arrangements that restrict competition. The EA administers the application of across all levels of the electricity sector.

[17] New Zealand Electricity Authority 2020, "Operations, Pricing manager"
[18] Security Standards Assumptions Document, 2012.

2.4.3 Market Price Cap, and Any Secondary Cap

There is no Market Price Cap set by the EA or the system operator. The default value of lost load in the Code is 20,000 NZD/MWh but is not indexed to inflation. There are also no market-based price caps to limit sustained volatility or high price exposure like the secondary price cap in the WESM.

However, the electricity code allows the EA to declare an Undesirable Trading Situation (UTS), defined as "an extraordinary event which threatens, or may threaten confidence in, or the integrity of, the wholesale electricity market that cannot be resolved under the Code". The EA has intervention powers to set prices that are lower than market outcomes if the prices do not reflect actual scarcity (such as instances of potential collusion between participants), or where outcomes would threaten market confidence or integrity. High spot prices combined with ineffective risk management by market participants would not be an UTS.

2.4.4 Market Price Floor

There is no market price floor set by the EA or SO. This is likely due to minimal units in the NZEM with unit commitment constraints as the share of coal generation was only 5% in 2020 and 2021.[19]

2.4.5 Equivalent Caps and Floors for Market Reserves

There is no market price cap on reserves, but there is a minimum $0/MWh floor for market reserves.

2.4.6 Equivalent Caps and Floors for Generator Offers

There are no caps on the offer prices from generators, however, all price bands have a floor of $0/MWh.[20]

2.4.7 Compliance and Market Monitoring Measures

Compliance in the market is the responsibility of the EA's Market Monitoring Team, which include the identification of potential breaches of the relevant NZEM codes and considering whether dispatch outcomes were consistent or materially different to rational offers that would have been made in a competitive market.[21] Enquiries and investigations are initiated based on these compliance initiatives, however, can also be initiated by the Responsible Minister, the Minister for Energy (under Section 18 of the Electricity Industry Act 2010).

In 2021, a review of competition dynamics was initiated after sustained high electricity prices following a gas field outage in 2018 and found that the existing market structures, namely contracting, created incentives for some generators to 'conduct inefficient price discrimination' at the detriment of consumers.[22] EA subsequently released a decision paper to improve competition in the NZEM which included a long list of actions to promote competition in the transition.[23] One of the main pillars was to facilitate investment in new renewable generation through various improved initiatives (regular monitoring of investments, collecting of contracts and firming agreements, improving disclosure on electricity hedges, and analysis of thermal generation transition risks).

[19] Energy Statistics, Ministry of Business Innovation and Employment.
[20] Section 13.15, Electricity Industry Participation Code 2010.
[21] The Authority's approach to monitoring the new trading conduct rule, EA, June 2021.
[22] https://www.ea.govt.nz/projects/all/review-of-wholesale-market-competition/
[23] Promoting competition in the wholesale electricity market in the transition toward a renewables-based electricity system, Electricity Authority, May 2023.

The Electricity Authority monitors the market and publishes regular reports on market performance, including prices, generation, and investment trends. This transparency helps to ensure that market participants are making informed decisions and that the market is operating efficiently.[24] The key monitoring measures relating to price controls include:

- Weekly trading conduct reports highlighting potential breaches of its trading conduct rule, and
- Quarterly reviews into market performance covering spot volatility and its drivers.

2.4.8 Considerations for End-User Costs, Efficient Investment and Energy Transition Requirements

New Zealand's electricity objectives are to provide clean, reliable electricity to meet demand at the lowest possible cost to consumers. The absence of market price caps in New Zealand and its focus on scarcity pricing would support investment. With limited with price controls in place, efficient end-user costs would require sufficient competition and a fully functioning contracts market but would arguably still be lacking in consumer protections compared to other jurisdictions. At present, there is a disconnect between the value consumers place on reliability, which is fixed and infrequently updated, and the lack of a market price cap.

A recent recommendations paper by the Market Development Advisory Group for the EA, examining various NZEM issues in the context of achieving higher renewable energy penetration, suggested reforms including a review of scarcity pricing parameters (including the market price cap).[25] Continued investment in renewable energy in the NZEM has also led to much higher spot price volatility[26], which has various market implications, including efficient price discovery, renewable energy revenue adequacy, contracting, and financial risks without price caps.

2.5 Pennsylvania New Jersey Maryland (PJM)

PJM includes several markets to balance supply and demand and ensure reliable and cost-efficient electricity. The PJM includes a capacity market[27] which is different to the WESM's energy-only design, but also includes Day-Ahead and Real-time energy, and ancillary services markets. Like the WESM, the PJM uses LMP to determine the price of electricity at different locations within the market, considering the constraints of the transmission system.

2.5.1 Reliability Standard

PJM and several other US markets have a "capacity market," which is a set of auctions to procure commitments to provide capacity out to the three-year timeframe to meet an ISO forecast of peak demand conditions plus a target planning reserve margin (the "installed reserve margin," IRM), as modulated by an administrative demand curve for capacity and reflecting zonal delivery constraints.[28]

The capacity market is called the "Reliability Pricing Model" in PJM and includes a model of zonal deliverability.[29] This procurement typically results in having enough capacity to satisfy operating

[24] https://www.ea.govt.nz/industry/monitoring/
[25] Price discovery in a renewables-based electricity system, Market Development Advisory Group, Dec 2023.
[26] https://www.ea.govt.nz/news/eye-on-electricity/past-and-future-spot-market-volatility/
[27] Reliability Pricing Model (RPM), this market ensures that there is sufficient generation capacity available to meet future peak demand. Generators receive payments for committing to provide power when needed.
[28] Section 5. Monitoring Analytics 2024, "2023 State of the Market Report for PJM"
[29] PJM 2023, "PJM Manual 18: PJM Capacity Market, Revision: 58"

requirements on essentially all days. For the June 2024 auction, the target Installed Reserve Margin is 17.7% and this is based on a one day in ten years loss of load expectation criterion.

2.5.2 Competition Law

The Energy Policy Act of 2005 is the federal policy for wholesale competition in the US, which covers three principal policy areas relating to competition in wholesale power markets, effective regulation to protect consumer interests, and energy infrastructure investments.[30] The North American Electric Reliability Corporation is responsible for the North American bulk power system which covers PJM.

2.5.3 Market Price Cap, and Any Secondary Cap

PJM caps energy prices (energy component of LMP) to 3,700 USD/MWh and is not indexed.[31] PJM's (energy) market price cap would account for capacity market payments, meaning the energy-only price for supply shortfalls would be lower than an energy-only context such as the WESM. The capacity market mechanism (generally) ensures sufficient capacity to meet reliability targets.

To date, the PJM has no secondary price cap, however, discussions and proposals were put forward in 2022 and 2023 for a secondary price cap, or 'circuit breaker' in the PJM, due to the implications of sustained high prices putting the financial integrity of the PJM market at risk.

2.5.4 Market Price Floor

PJM's real-time and day-ahead energy markets has a price floor at 0 USD/MWh.[32]

2.5.5 Equivalent Caps and Floors for Market Reserves

Market reserve price caps are set to 850 USD/MWh (not indexed), with a floor of $0/MWh.

2.5.6 Equivalent Caps and Floors for Generator Offers

Generation offers are effectively capped at 1000 USD/MWh, with some transactions allowed at higher prices based on a Federal Energy Regulatory Commission Order, while demand bids are capped at 2,000 USD/MWh to 3,700 USD/MWh.[33]

2.5.7 Compliance and Market Monitoring Measures

The PJM Market Monitoring Unit, a fully independent external market monitor for PJM, is responsible for the compliance of participants with the rules, standards and procedures. The reviews provide detailed State of the Market reports on a quarterly basis. In relation to price caps and volatility, the regular reporting covers the following areas:

- Competitiveness at aggregate and local market levels (structure and concentration),
- Competitiveness of participant behaviour (and undue market power),
- Market performance and tests for market power,
- Detailed pricing reviews and underlying supply and demand conditions,

[30] Energy Policy Act of 2005, Fact Sheet, FERC, 2006.
[31] PJM 2024, "2024 Quarterly State of the Market Report for PJM: January through March". Transmission penalty factors can increase this by a further $2000/MWh (USD).
[32] Negative prices are allowed under specific conditions.
[33] PJM 2024, "PJM Manual 11: Energy & Ancillary Services Market Operations, Revision: 130"

- Shortage and shortage pricing
- Actual and potential design flaws that inhibit the efficient functioning of the market
- For any issues identified, the reports also provide recommended improvements

2.5.8 Considerations for End-User Costs, Efficient Investment and Energy Transition Requirements

Given the current debate around secondary price cap in the PJM, several shortcomings of its market price caps were raised. These were mainly related to the setting of the price caps which do not consider the value placed on reliability by consumers. The main parameter used in determining the price cap, the Operating Reserve Demand Curves, is a proxy for demand bidding at times of high prices. It has been noted PJM's shortage pricing mechanism without a secondary cap, under extreme conditions, potentially threatens the health and integrity of the market.

2.6 Alberta Energy System Operator (AESO)

2.6.1 Reliability Standard

Plans for a capacity market was cancelled and the Alberta electricity market, as stated in AESO, 2008, remains an energy-only market, where the market determines the appropriate level of adequacy over the long term.[34] There is a "bridging mechanism" that is designed to respond to capacity shortfalls in the two year ahead time frame and, moreover, planning reserve margins are forecast by AESO for the five year ahead time frame to provide information to the market about investment opportunities.

The metric used by AESO is referred to as the Two-Year Probability of Supply Adequacy Shortfall Metric and has been set to 2,048 MWh based on extensive consultation with stakeholders.[35] The criterion roughly corresponds to a one in ten-year event frequency, Given annual delivered electric energy of about 87 TWh in 2023[36], loss of 2,048 MWh in a single year would correspond to roughly 0.002% of energy unserved over a year, which is similar to the ANEM standard.

If conditions forecast by AESO suggest reliability worse than the standard, AESO is allowed to procure load shedding services, back-up generation, or emergency portable generation. The intention is that by responding to forecast shortfalls in the two-year time frame, investors and developers have time to respond to market signals by developing new generation without significant interruption to supply.

The AESO operationalizes other WECC and NERC reliability standards through its market rules that are supplemented by Alberta Reliability Standards (ARS). Alberta has a pricing framework that has been designed around long-term sustainability of investments and reliability as the key framework pillars.[37] The pricing framework was last reviewed in 2020.

2.6.2 Competition Law

Competition law in Alberta is governed by the FAIR, EFFICIENT AND OPEN COMPETITION REGULATION (Alberta Regulation 159/2009). They key legislation in the Act include:

- Prohibited conduct by an electricity market participant,

[34] Executive Summary. AESO, 2008, "Long Term Adequacy Metrics, Threshold and Threshold Actions Recommendation Paper"
[35] Long-Term Adequacy Report, AESO, May 2024.
[36] https://www.aeso.ca/market/market-and-system-reporting/annual-market-statistic-reports/
[37] Pricing Framework Recommendation to the Minister, AESO, July 2020.

- Market share controls which include reporting of market share and establishing a maximum market share cap of 30%.[38]

2.6.3 Market Price Cap, and Any Secondary Cap

AESO has a pricing framework which includes a price cap of 1,000 CAD/MWh (not indexed). The level of the market price cap is not determined by forward looking estimates but is based on analysis of historical conditions, i.e., whether it was high enough to incentivise supply and demand responses as the system approaches scarcity and shortage conditions.

There is no secondary price cap, however, the Alberta government more recently passed a secondary offer price cap of $125/MWh or 25 times the gas reference price (indexed) to all non-renewable and non-storage generators with 5% or more total market share. The secondary price cap is triggered based on a measure of cumulative net revenues exceeding of 1/6th of the annualised fixed costs of a reference generation unit.[39]

2.6.4 Market Price Floor

There is a price floor of 0 CAD/MWh. The AESO noted several other markets with negative price floors, and assessed whether having a negative price floor would improve market efficiency, however, based on the assessment of historical supply surplus events between 2015-2019, found negative pricing would have provided minimal efficiency gains.

2.6.5 Equivalent Caps and Floors for Market Reserves

Same as the energy price cap and floor.

2.6.6 Equivalent Caps and Floors for Generator Offers

There are offer caps set at 999.99 CAD/MWh and an offer price floor of 0 CAD/MWh.

2.6.7 Compliance and Market Monitoring Measures

The AESO assesses market participant compliance with ISO rules, Alberta Reliability Standards and the Settlement System Code rules set out in Alberta Utilities Commission Rule 021. The AESO regularly reports on wholesale electricity price, supply and demand, transmission and generation outages, ancillary services and operating reserves and other resources for market participants.

In addition to the market reports, there regular pricing framework review[40] which covers the adequacy of the market price caps as well as its 'Market Power Mitigation Advice to Minister' report.[41]

2.6.8 Considerations for End-User Costs, Efficient Investment and Energy Transition Requirements

The pricing framework that establishes market price and offer caps in Alberta is designed to ensure the energy-only market effectively delivers both efficient short-term and long-term investment signals

[38] Electricity market participant shall not hold offer control in excess of 30% of the total maximum capability of generating units and energy storage resources in Alberta.
[39] MARKET POWER MITIGATION REGULATION, ALBERTA REGULATION 43/2024.
[40] https://www.aeso.ca/stakeholder-engagement/completed-engagements/market/market-efficiency-pricing-framework/
[41] Market Power Mitigation Advice to Minister, AESO, Nov 2019.

to encourage the construction of new generation. Effective short- and long-term signals work together to ensure electricity supply adequacy, reliably and affordably meeting system demand. However, the methodology for setting these caps is not closely aligned with the forward-looking costs of building new generation or the underlying value that consumers place on reliability.

2.7 Ontario Independent Electric System Operator (IESO)

Ontario's IESO operates a unique "Hybrid" electricity market that features spot price competition amongst generation facilities and a competitive capacity procurement mechanism. Most generation is either publicly owned or procured through long-term PPAs. The Ontario market operates on an hourly dispatch basis and employs Real-Time, Pre-Dispatch and Day-Ahead dispatch engines that optimize least-cost security constrained solutions within the physical limitations of its power system. This provides the IESO with an integrated short-term reliability process based on a nodal system model that places requirements for system adequacy as a prerequisite condition for dispatch schedules.

Ontario's IESO conducts an annual capacity auction to secure sufficient capacity reserves on a short-term basis and has recently completed the first long-term capacity auctions under its Resource Adequacy Framework.[42] With a highly centralized electricity market, the IESO has much more responsibility for operating the market through its central dispatch optimization process than IEMOP does for the WESM.

2.7.1 Reliability Standard

IESO, as part of the North American Electricity Reliability Corporation (NERC), is subjected to the reliability standard mandated by its regional coordinating council, the Northeast Power Coordinating Council (NPCC). In Directory 1 of the NPCC Regional reliability reference legislation, Requirement 4 states that:

"Each Planning Coordinator or Resource Planner shall probabilistically evaluate resource adequacy of its Planning Coordinator Area portion of the bulk power system to demonstrate that the loss of load expectation (LOLE) of disconnecting firm load due to resource deficiencies is, on average, no more than 0.1 days per year."[43]

2.7.2 Competition Law

General competition laws, such as the Competition Act (administered by the Competition Bureau), apply to the electricity market in Ontario. This federal legislation is designed to prevent anti-competitive practices and promote fair competition across various industries, including electricity. The Act addresses issues such as price-fixing, monopolistic practices, and mergers that could significantly reduce competition. The Ontario electricity market rules governing competition are an extension of section 32 of the Electricity Act and are administered by the IESO. A memorandum of understanding was signed by the Competition Bureau to increase the IESO's ability to monitor compliance with the broader competition laws of Canada.

2.7.3 Market Price Cap, and Any Secondary Cap

The price cap in Ontario's market is 2,000 CAD/MWh (not indexed). There is no secondary price cap. There is a separate capacity payment as part of Ontario's electricity market design.

[42] https://www.ieso.ca/Sector-Participants/Resource-Acquisition-and-Contracts/Overview
[43] Refer to the following for how this is modelled. Resource Adequacy and Energy Assessments Methodology, IESO, Dec 2020.

2.7.4 Market Price Floor

The price floor in Ontario's market is -100 CAD/MWh. This is higher than the floor applied to generator offers.

2.7.5 Equivalent Caps and Floors for Market Reserves

Ontario has a Maximum Operating Reserve Price that is set to 2000 CAD/MWh (not indexed) and has a floor of 0 CAD/MWh.[44]

2.7.6 Equivalent Caps and Floors for Generator Offers

Market participants can submit offers up to 2,000 CAD/MWh but has a floor of -2,000 CAD/MWh. This allows for added flexibility to participants to manage its operations, noting this is different (lower) than the actual market price floor. The floor was introduced to deal with surplus generation requirements. Reserve offers are bound by 0/MWh and the Maximum Operating Reserve Price of 2000 CAD/MWh.

2.7.7 Compliance and Market Monitoring Measures

The Market Assessment Unit (within MACD) monitors the market for exploits, manipulations or circumvention of Ontario electricity market rules. The Market Assessment and Compliance Division of IESO enforces compliance with the market rules. The MACD has the authority to issue non-compliance rulings and impose sanctions, including financial penalties.

Market monitoring and surveillance initiatives include:

- Annual State of the Market Reports covering competitiveness and contracting structures, long-term efficiency of investment, inefficiencies of current market design and comparative assessment of dispatch efficiency.
- Market Surveillance Panel Reports covering high energy prices, and anomalous market outcomes, and market design implications.[45]

2.7.8 Considerations for End-User Costs, Efficient Investment and Energy Transition Requirements

The Ontario electricity market addresses investment through its capacity procurement mechanism based on its reliability standard, however, it is unclear whether the level that has been set accounts for the trade-off consumers place on reliability which if not accounted for, can potentially lead to inefficient investment and consumer costs.

A report for IESO recommended the price cap be lifted to reflect try market scarcity levels to ensure reliability is not undervalued.[46] The report studying potential compensation options for demand response highlighted the low price cap as an impediment to the successful integration of demand response with broader implications for efficient operations and investment in Ontario.

[44] Guide to Operating Reserve, October 2011.
[45] Example: Market Surveillance Panel Report 37, OEB, March 2023.
[46] Energy-Market Payment Options for Demand Response in Ontario, The Brattle Group, May 2020.

2.8 Key Findings

The following tables summarises the high-level comparison to the WESM across the price mitigation measures reviewed. The reliability standard and whether capacity payments are also included for context. Some of the key observations include:

- The current price cap settings in the WESM have been based on a traditional energy mix, and has not been updated to support the energy transition requirements.
- The design of the various markets all has efficient dispatch, investment and end-user costs at the core of its objectives. However, the determination of the price caps or price mitigation measures in the WESM is not captured within a robust framework to assess the important trade-off between end-user costs and the value of reliability.
- Primary price caps are applied to final settlement prices. Spot prices in the WESM, however, can and generally do exceed the primary offer caps that are currently imposed.
- For markets with low primary price caps, there are questions relating to the efficiency of dispatch if the price cap is below that of demand response.
- Secondary price caps are used to limit sustained high price exposure, which can destabilise and threaten the integrity of the market. Alberta (energy-only) has recently implemented this even though it has a relatively low primary price cap. The considerations under which the duration under which SEC is triggered (cumulative price threshold) and SEC price level is set is generally not clear. However, in Australia, the factors considered also include incentivising long-duration storage (relates to the cumulative price threshold look-back window), the potential reduction in hedging and impact on the contracting market, and financial integrity.
- The market price floor is generally set at 0, unless there is a need to allow its underlying generation fleet to manage unit commitment operations. The level of renewable energy generation is likely a factor in driving this setting.
- The review frequency of the adequacy of the price settings or price mitigation measures vary across the jurisdictions. Frequent monitoring of price volatility is ideal but should also consider the potential investment risks of ad-hoc changes to the underlying price settings which is expected to drive revenue adequacy.
- Most of the jurisdictions currently do not explicitly factor in the role of the price settings in incentivising broader energy transition requirements. However, this is likely to be less of a problem in markets with capacity payment mechanisms.

Table 4 Summary Comparison of Price Mitigation Measures

Price Mitigation Measure	WESM (Philippines)	Australia	New Zealand	Pennsylvania New Jersey Maryland	Alberta	Ontario
Capacity payments	No	No	No	Yes	No	Yes
Reliability standard	No quantitative measure exists.	Expected unserved energy to be less than 0.002% of annual demand in any region.	Winter energy margins and winter capacity margins which is set in accordance with the total expected energy shortfall (0.06% of total demand) and expected hours of energy or reserve shortfall (22 hours per year).	Target Installed Reserve Margin of 17.7%, based on a one day in ten years loss of load expectation criterion.	Two-Year Probability of Supply Adequacy Shortfall Metric and has been set to 2,048 MWh (equivalent to 0.002% of energy demand)	The loss of load expectation (LOLE) of disconnecting firm load due to resource deficiencies is, on average, no more than 0.1 days per year

Price Mitigation Measure	WESM (Philippines)	Australia	New Zealand	Pennsylvania New Jersey Maryland	Alberta	Ontario
Competition Law	EPIRA of 2001 or Republic Act 9136 imposes competition limits on generation companies not being allow to "singly or in combination, own, operate or control more than thirty percent (30%) of the installed capacity of a grid and/or twenty-five percent (25%) of the national installed generating capacity."	Australian Consumer Competition Council (ACCC) governs competition policy in Australia and is required to investigate market structure and assess whether a market is giving rise to competitive outcomes or not. In situations where competition is assessed to be negatively impacted the ACCC may take measures such as breaking up dominant players or monopolies or imposing additional price controls on the industry.	The NZEM is governed by broader competition legislation in New Zealand's Commerce Act1986 which prohibits certain conduct and business arrangements that restrict competition. The EA administers the application of across all levels of the electricity sector.	The Energy Policy Act of 2005 is the federal policy for wholesale competition in the US, which covers three principal policy areas relating to competition in wholesale power markets, effective regulation to protect consumer interests, and energy infrastructure investments. The North American Electric Reliability Corporation is responsible for the North American bulk power system which covers PJM.	Competition law in Alberta is governed by the FAIR, EFFICIENT AND OPEN COMPETITION REGULATION (Alberta Regulation 159/2009).	The Ontario electricity market rules governing competition are an extension of section 32 of the Electricity Act and are administered by the IESO. A memorandum of understanding was signed by the Competition Bureau to increase the IESO's ability to monitor compliance with the broader competition laws of Canada.
Market Price Cap (MPC)	There are only caps on generation offers. The final settlement price can be significantly higher due to other constraint costs in the system such as the cost of congestion.	16,600 AUD/MWh (indexed)	None	3,700 USD/MWh (not indexed)	1,000 CAD/MWh (not indexed)	2,000 CAD/MWh (not indexed)

Price Mitigation Measure	WESM (Philippines)	Australia	New Zealand	Pennsylvania New Jersey Maryland	Alberta	Ontario
Market Price Floor (MPF)	There is only a floor applied to generator offers, i.e., settlement prices can be lower than generator the offer floor.	-1000 AUD/MWh (not indexed)	None	0 USD/MWh	0 CAD/MWh	-100 CAD/MWh (not indexed)
Secondary Price Cap (SPC) Mechanism	Secondary Price Cap (SPC) Mechanism: If the rolling average of the generator weighted average prices (GWAP) for 3-days exceeds the price threshold (9000 Php/MWh then SPC is imposed as the cap. SPC is set to 6,245 Php/MWh (not indexed)	Cumulative Price Threshold (CPT) and Administered Price Cap (APC) and Administered Price Periods (APPs): CPT: sum of market prices in a region exceeds 1,398,100 AUD (950,988 USD) in the previous 2016 trading intervals (rolling 7 days) under which case the APC of 500 AUD/MWh is applied (not indexed)	None	None	Secondary offer price cap of $125/MWh or 25 times the gas reference price (indexed) to all non-renewable and non-storage generators with 5% or more total market share. The secondary price cap is triggered based on a measure of cumulative net revenues exceeding of 1/6th of the annualised fixed costs of a reference generation unit.	None
Reserve price caps and floor	There are no price caps or floor on reserve prices.	16,600 AUD/MWh and 0 AUD/MWh (indexed)	Floor of 0 NZD/MWh, but no cap for reserve prices	850 USD/MWh (not indexed), with a floor of 0 USD/MWh	1,000 CAD/MWh and 0 CAD/MWh (not indexed)	2000 CAD/MWh (not indexed) and has a floor of 0 CAD/MWh

Price Mitigation Measure	WESM (Philippines)	Australia	New Zealand	Pennsylvania New Jersey Maryland	Alberta	Ontario
Bid Price Cap & Floor Prices	32,000 Php/MWh and -10,000 Php/MWh (not indexed)	Set in line with the Market Price Cap and Market Price Floor.	Only a floor of 0 NZD/MWh	Generator offers generally capped to 1000 USD/MWh	999.99 CAD/MWh and 0/MWh floor.	2,000 CAD/MWh but has a floor of 0 CAD/MWh (not indexed)
Compliance Monitoring	PEMC - Enforcement and Compliance Office (ECO) undertakes routine monitoring of market participants conformance to WESM Rules and Market Procedures – including must-offer rule compliance, and dispatch instruction compliance.	Australian Energy Regulatory (AER) is responsible for routinely undertaking assessments of market participant compliance, with assistance from the Market Operator, AEMO.	Compliance in the market is the responsibility of the EA's Market Monitoring Team, which include the identification of potential breaches of the relevant NZEM codes. Enquiries and investigations are initiated based on these compliance initiatives, however, can also be initiated by the Responsible Minister, the Minister for Energy (under Section 18 of the Electricity Industry Act 2010).	The PJM Market Monitoring Unit, a fully independent external market monitor for PJM, is responsible for the compliance of participants with the rules, standards and procedures.	The AESO assesses market participant compliance with ISO rules, Alberta Reliability Standards and the Settlement System Code rules set out in Alberta Utilities Commission Rule 021.	The Market Assessment Unit (within MACD) monitors the market for exploits, manipulations or circumvention of Ontario electricity market rules. The Market Assessment and Compliance Division of IESO enforces compliance with the market rules. The MACD has the authority to issue non-compliance rulings and impose sanctions, including financial penalties.

Price Mitigation Measure	WESM (Philippines)	Australia	New Zealand	Pennsylvania New Jersey Maryland	Alberta	Ontario
Market Surveillance Monitoring	PEMC Market Surveillance Committee routinely monitors the WESM outcomes and reports against several defined market monitoring indices and other measures that are focused on detection of anti-competitive behaviour.	Australian Energy Regulator (AER) responsible for routinely monitoring Australian NEM for exercise of market power and anti-competitive market behaviour. AER may conduct detailed investigations into instances where anti-competitive behaviour has been identified.	The Electricity Authority monitors the market and publishes regular reports on market performance, including prices, generation, and investment trends. This transparency helps to ensure that market participants are making informed decisions and that the market is operating efficiently.	Market monitoring assessments are conducted by the PJM Market Monitoring Unit. Regular reporting includes competition and market power, detailed pricing reviews, shortage and shortage pricing impacts, and potential market design inefficiencies.	In addition to the regular market reports, the AESO also conducts regular pricing framework reviews which cover the adequacy of the market price caps as well as its 'Market Power Mitigation Advice to Minister' report.	Market monitoring and surveillance by the Market Assessment Unit include market and surveillance reports covering high price events, competitiveness and contracting, long-term efficiency of investment, inefficiencies of current market design and comparative assessment of dispatch efficiency, and market design implications.

Price Mitigation Measure	WESM (Philippines)	Australia	New Zealand	Pennsylvania New Jersey Maryland	Alberta	Ontario
Consideration for efficient operation and investment.	There is no market price cap. The offer caps have no direct link to the key objectives of the WESM relating to efficient investment and dispatch.	There is a reliability framework that sets out the appropriate level for reliability based on the value consumers place on reliability. The required settings (such as the market price cap) are set to meet the reliability targets.	At present, there is a disconnect between the value consumers place on reliability, which is fixed and infrequently updated, and the lack of a market price cap. Recommendations on market reform include a review of scarcity pricing parameters (price caps).	The setting of the price caps does not consider the value placed on reliability by consumers. PJM's shortage pricing mechanism without a secondary cap, under extreme conditions, is a potential risk to the market.	Although the pricing framework sets out its considerations for long-term investment and affordability, the methodology in setting the caps, however, is not firmly linked to forward-looking new entrant build costs or underlying value placed on reliability by consumers.	The Ontario electricity market addresses investment through its capacity procurement mechanism based on its reliability standard, however, it is unclear whether the level that has been set accounts for the trade-off consumers place on reliability. The low energy price cap has broader implications for efficient operations.
Does the current price mitigation or reliability framework account for energy transition requirements?	There are no established mechanisms in the current framework to promote or accommodate renewable energy	Yes, the price caps are based on modelling of a future state of the system and account for the cost of storage.	No, however, current recommendations specifically include considerations for RE investment.	There are no established mechanisms in the current framework to promote or accommodate renewable energy	There are no established mechanisms in the current framework to promote or accommodate renewable energy	There are no established mechanisms in the current framework to promote or accommodate renewable energy

2.9 Proposed Approach to Setting Price Caps in the WESM

Based on the international review, IES recommends a series of reforms to the current regulatory framework, focusing on reliability and the associated price settings. These reforms aim to enhance transparency and provide clearer investment signals to support the necessary energy transition and broader objectives of achieving efficient costs and sustainable investment. The broad recommendations are aligned with the reliability framework adopted in the Australian National Electricity Market and is summarised below, consistent with Figure 4.[47]

- **Establishing the Value of Customer Reliability in the WESM**. The objective is to determine how much end-consumers—a representative mix of residential, commercial, and industrial customers—are willing to pay for reliability. The methodology and underlying assumptions used in this calculation should undergo thorough consultation and quality assurance, given their significant implications. These assumptions can affect price settings, which, in turn, will influence tariffs.[48]

- **Setting the form of the reliability standard**. The reliability standard serves as a metric for assessing the level of reliability. Currently, the WESM Grid Code defines this as an average Loss of Load Expectation. If any reforms are considered, the standard should be aligned with the preferences of the underlying end-users (refer to Table 5 for examples). This should also be thoroughly consulted with all stakeholders.

Table 5 Examples of reliability measures (form of the reliability standard)

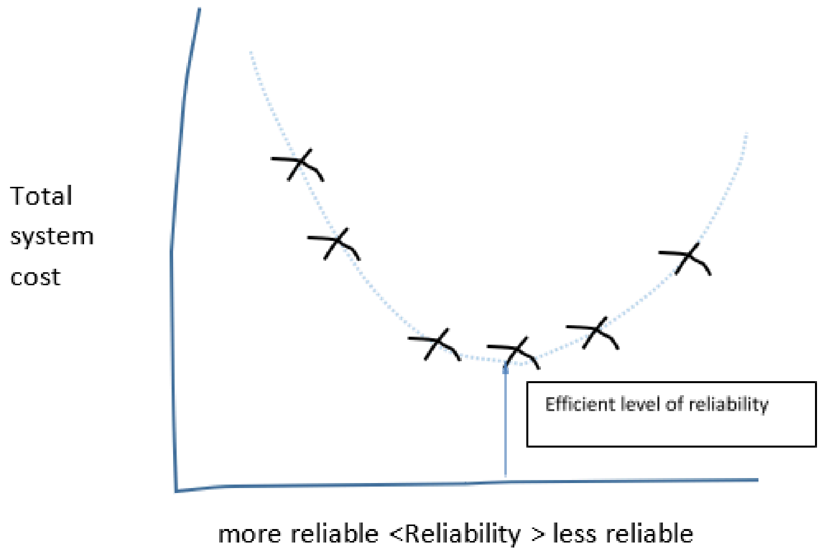
Examples	Metric/measure[49]
I do not want to be inconvenienced more than X days per year	Loss of Load Expectation (this is measured in days)
I need Y% uptime on my data centres	Loss of Load Hours (measured in hours)
I am indifferent, other than being served at least Z% of my energy requirements over the year	Expected unserved energy (or Expected Energy Not Served) which can be defined in MWh or percentage of demand
I want to avoid long duration outages at all costs (low probability but high impact)	Inclusion of a tail-risk measure

- **Modelling the efficient level of the reliability standard**. Once the value of customer reliability (VCR) and the form of the reliability standard are established, detailed modelling is conducted to explicitly examine the trade-off between the cost of unserved energy (valued at the VCR) and the costs associated with additional generation and transmission investments. This trade-off is depicted in Figure 6, which illustrates that a system with high reliability incurs

[47] The descriptions are intended to be high-level only.
[48] Examples include any cost-benefit analysis for regulated transmission assessments which would trade-off reliability with and without the project.
[49] Probabilistic measures have been used here. The statistical measure needs to also be considered. E.g., Is this a maximum or average metric, and over what frequency.

very high costs due to generation and transmission redundancy. Conversely, a system with very low reliability also faces high costs, primarily due to the economic cost of unserved energy. The optimal point, where system costs are minimised, corresponds to the appropriate level for the reliability standard.

Figure 6 Trade-off between reliability and system costs



- **Modelling to establish reliability new entrant**. The next step is to conduct detailed market simulations to understand what the reliability gap is over the modelled horizon and the least cost reliability new entrant. See Table 6.

Table 6 Reliability new entrant modelling

Step	Details[50]
Establish the reliability gap	Modelling is conducted over the horizon with only existing and committed generators. It is likely a reliability gap exists, where the reliability gap is defined as the reliability shortfall in achieving the reliability standard.
Least cost modelling to determine the new entrant portfolio and reliability new entrants	The second step is, under least-cost principles, determine the optimal new entrant portfolio that needs to developed in order to meet the reliability standard. Out of this portfolio, there would be generation types that would be identified as the reliability new entrant.

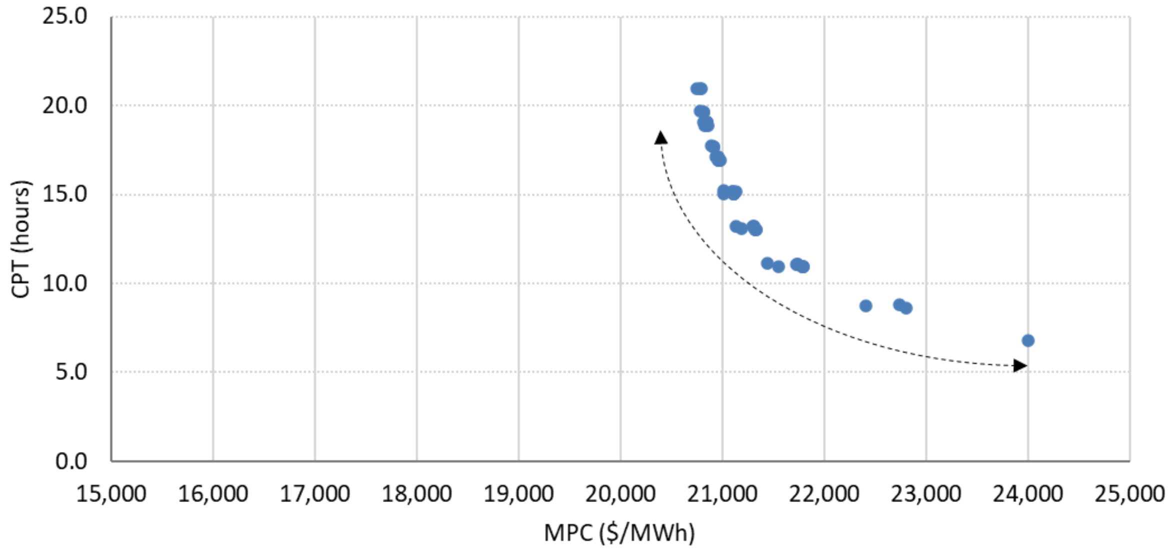
- **Determination of the price settings (primary price cap and secondary price cap).** The reliability new entrants identified in the previous step are unlikely to recover their fixed costs under low price settings. However, these entrants are essential to meet the reliability standard. Therefore, price settings must be structured to incentivise investment in this

[50] Note for probabilistic reliability measures, monte carlo simulations need to be carried out.

reliability capacity, ensuring that these plants can recover both their variable and fixed operating costs. Additional modelling is required to determine the appropriate price settings necessary to achieve revenue adequacy. However, several complexities must be considered:

- Sampling Issue: The modelling must account for the probabilistic nature of the reliability measure. There will be many years with no unserved energy and a few years with some. The price settings and revenue adequacy conditions for the new reliability entrants need to reflect this variability.
- Price Cap Settings: There are two key price settings—the primary price cap and the secondary price cap—that influence revenue adequacy. It is mathematically possible to achieve revenue adequacy with different combinations, such as a high primary price cap with a low Cumulative Price Threshold (CPT) or a low primary price cap with an extended CPT. This is illustrated in Figure 7, which shows a frontier of feasible combinations where an open gas turbine in the Australian NEM can still recover its costs.
- Considerations for Price Cap Combinations:
  - A high primary price cap with a short CPT duration may disincentivise generation technologies with long-duration storage (or no energy availability constraints) as revenues are capped almost immediately.
  - A low primary price cap with an extended CPT might discourage and stifle the contracts market because the spot market would provide a natural hedging mechanism. This could lead to a market failure, where retailers are less inclined to contract with generators that require secure revenue streams for project approvals and financing.

Figure 7 Possible combinations of the primary price cap and secondary price cap



Note: This chart (in AUD) shows all combinations of price settings that deliver revenue adequacy for an open-cycle gas turbine which was the least cost reliability new entrant in the Australian Reliability Settings and Standards Review 2022. CPT in the Australian NEM is defined as an accumulated price threshold and is expressed in hours of the Market Price Cap (MPC) for simplicity here.

- **WESM Rules**. The considerations discussed must be incorporated into the WESM Rules to ensure transparent and reliable mechanisms that support sustainable investment. Additionally, the framework should include regular review periods to update the price settings and other assumptions, such as the VCR, to ensure that the price settings remain aligned with changes in underlying supply costs over time.

The establishment of a reliability framework which drives the appropriate/efficient level of price caps is expected to be a lengthy process, given its extensive impact on various operational and planning processes within the WESM, as well as on end-user costs and both current and future investments. To ensure proper design and implementation, a transparent and robust process involving extensive consultation with all stakeholders, including consumer groups, is essential. This process may take several years and could involve transitional measures. An example is provided below.

Table 7 Regulatory timeline (example)

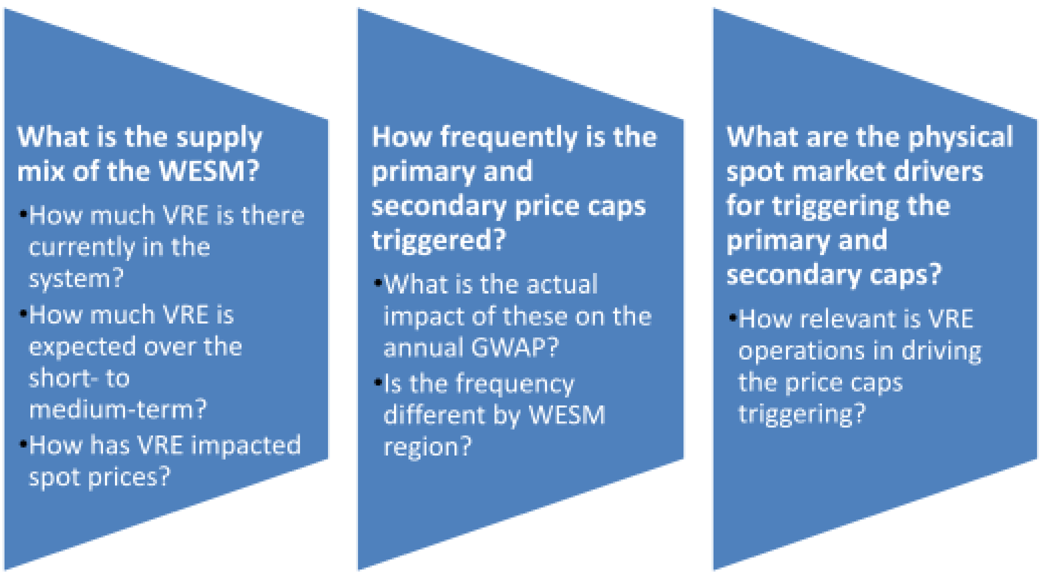
Process	Description	Timing (expressed as months from initiation at time T)
1. Initiation of a potential rule change and Terms of Reference	Sets out the scope of the review, key principles and objectives, i.e., include the reliability framework in the WESM rules and related procedures.	T (although it may take up to 6 months to establish the Terms of Reference before this is formally initiated)

2. Release of an issues paper	Details the key features of the current process, the potential issues and other aspects of reliability and price caps, to be examined in more detail as part of this process. The intention is for the market to assist with the scoping of the review.	T + 1
3. Consultation and submissions	This is to ensure all material concerns and viewpoints are included in the review of the rule change	T + 4
4. Interim report	Establishes the final scope of the review and Technical Working Group/s.	T + 7
5. Review and assessment	This stage would include several staged components to cover all the requirements discussed above and would include requirements relating to potential rule change/s, detailed modelling, assessment of impacts, transition arrangements. There would be draft determinations (and consultation) prior to any final determination.	T + 25 (in the case of the WESM where no reliability framework currently exists)
6. Completion of review and implementation	Implementation of rule changes and any other transition requirements due to the significant change across operational and investment timeframes.	T + 36

3 Assessment of WESM Price Trends

The assessment of WESM price trends intends to explore the levels of volatility in the WESM, relative frequency of triggering the primary and secondary price caps, and the physical spot market drivers. Understanding the correlation between the increasing penetration of renewable energy and the price volatility in the market is pivotal in aligning the policies to attract investments in renewable energy. Figure 8 summarises the key questions that are addressed in the analysis.

Figure 8 Analysis of WESM Price Trends



3.1 Assumptions and Limitations

The analysis to address the key questions presented is carried out to the extent of the availability of data. Table 8 summarises the assumptions and limitations of the analysis.

Table 8 Assumptions and limitations

Assumption or limitation	Description
Data - outstanding	Data on bilateral contract levels, regional demand and GWAP in the hourly market, as well as transmission system events is yet to be provided and integrated into the analysis.
Data – general	The nodal generator data was primarily used in this analysis. This set of data contains relevant information on generator types, generator bids and offers, real-time dispatch prices and schedules, and pricing corrections. Data during the hourly market from 26 December 2013 until 25 June 2021 were standardised to 5-minute intervals to align with the current 5-minute market.

Assumption or limitation	Description
Data - prices	The generator weighted average prices (GWAP) were computed from the prices and schedules of registered generator nodes in the WESM during the period. The prices and schedules for the hourly market was based on RTD for periods with no market intervention, and on adjusted RTX for periods with market intervention. Additionally, the RTD and adjusted RTX prices were capped to between -10,000 Php/MWh and 100,000 Php/MWh as these prices do not consider the impact of the price substitutions. For the 5-minute market, the DIPC price and energy was used without adjustments as they already include price mitigation measures. The same basis was used to calculate the frequency of periods at the market price cap and floor, and generator spot revenues.
Static analysis	The analysis presented here is does not account for generator behaviour as a function of any change to potential change to the price settings in the WESM.
Historical analysis	The WESM to date does not have a lot of RE and storage relative to its broader transition objectives. However, the analysis intends to highlight areas that should be considered in any broader price setting reform.
Pure market outcomes	Unless otherwise stated, the analysis is based on entirely commercial market outcomes, i.e., there are no government policies which may otherwise provide revenue adequacy for generator investments. The rationale is market design and price settings need to set for the sustainable and efficient investment irrespective of government policy intervention.

3.2 Supply and Demand

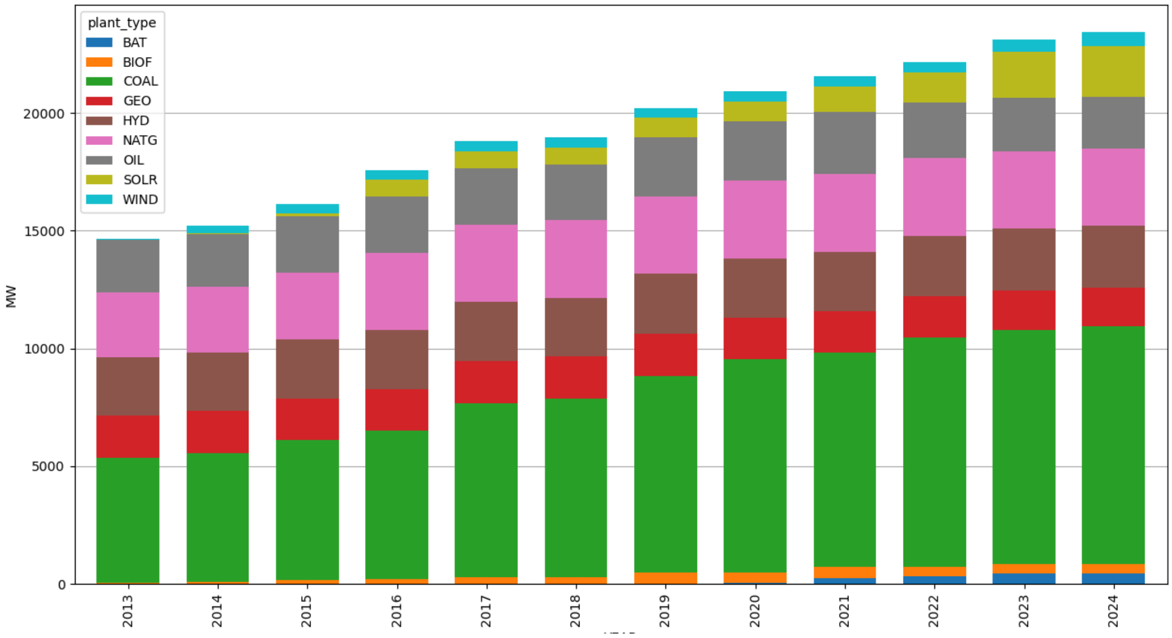
3.2.1 Historical Generation Capacities and Generation Mix

The combined annual installed capacities and the annual generation mix for Luzon and Visayas are shown in Figure 9 and Figure 10. The analysis is done only for the two regions as the commercial operations of WESM in Mindanao only began on 26 January 2023.

In 2014, coal held the largest share of the generation mix at 35.8%, with natural gas following at 18.2%. In the present, coal still dominates the generation mix with a share of 43.2%, and still followed by natural gas at 14%.

The share of VREs also increased throughout the period. Beginning at only 0.2% share of the generation mix in 2014, the installed capacities for solar and wind generators grew to 12% or a total installed capacity of 2,746 MW. The combined capacities for battery storage systems, solar, wind, and other renewables including geothermal, hydro, and biofuel constitute only 33.5% of the current supply mix. Despite the market experiencing higher levels of VRE generation in the recent years, the analysis of VRE's impact on price volatility remains limited due to its low share in the supply mix.

Figure 9 Combined Installed Capacities for Luzon and Visayas (2014-2024)



Notes: The generator technologies that are currently registered in the WESM are Battery Energy Storage Systems (BAT), Biofuels (BIOF), Coal-fired (COAL), Geothermal (GEO), Hydroelectric (HYD), Natural Gas (NATG), Oil-based (OIL), Solar (SOLR) and Wind.

Figure 10 Annual Generation Mix for Luzon and Visayas (2014-2024)

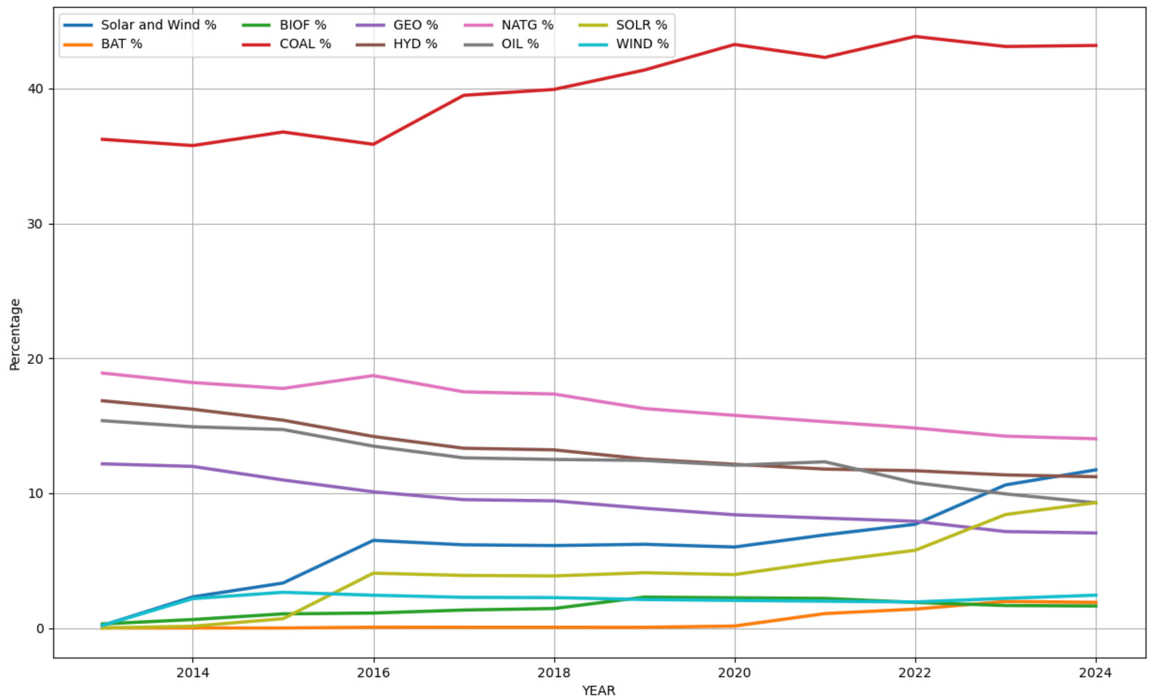


Table 9 and Table 10 summarises the generation capacities and generation mix throughout the covered period.

Table 9 Installed Capacities per Technology (Luzon and Visayas, MW)

YEAR	BAT	BIOF	COAL	GEO	HYD	NATG	OIL	SOLR	WIND	INSTALLED CAPACITIES
2013	0.00	44.10	5308.20	1783.00	2468.20	2769.10	2251.80	0.00	27.00	14,651.40
2014	0.00	94.90	5442.40	1,823,00	2468.20	2769.10	2269.90	19.80	330.90	15,218.20
2015	0.00	168.80	5935.00	1771.00	2486.50	2866.10	2374.90	110.92	426.90	16,140.12
2016	10.00	194.90	6304.30	1774.70	2496.20	3289.70	2369.90	714.73	426.90	17,581.33
2017	10.00	249.70	7419.70	1787.50	2503.80	3289.70	2370.10	731.65	426.90	18,789.05
2018	10.00	273.70	7572.70	1787.50	2504.80	3289.70	2370.10	731.67	426.90	18,967.07
2019	10.00	462.70	8363.70	1795.00	2532.80	3289.70	2511.60	827.57	426.90	20,219.97
2020	30.00	467.80	9042.30	1754.10	2536.70	3294.70	2522.10	827.57	426.90	20,902.17
2021	230.00	472.20	9112.30	1754.10	2537.90	3294.70	2653.90	1059.20	427.60	21,541.90
2022	310.00	419.70	9720.10	1754.10	2583.80	3285.50	2387.60	1276.70	427.60	22,165.10
2023	454.50	384.50	9961.00	1651.30	2621.70	3285.50	2296.80	1943.50	507.20	23,106.00
2024	444.50	381.70	10116.30	1649.60	2626.70	3285.50	2173.80	2176.20	569.70	23,424.00

Table 10 Capacity Share per Technology (Luzon and Visayas)

YEAR	BAT	BIOF	COAL	GEO	HYD	NATG	OIL	SOLR	WIND	INSTALLED CAPACITIES
2013	0.0%	0.3%	36.2%	12.2%	16.8%	18.9%	15.4%	0.0%	0.2%	14,651.40
2014	0.0%	0.6%	35.8%	12.0%	16.2%	18.2%	14.9%	0.1%	2.2%	15,218.20
2015	0.0%	1.0%	36.8%	11.0%	15.4%	17.8%	14.7%	0.7%	2.6%	16,140.12
2016	0.1%	1.1%	35.9%	10.1%	14.2%	18.7%	13.5%	4.1%	2.4%	17,581.33
2017	0.1%	1.3%	39.5%	9.5%	13.3%	17.5%	12.6%	3.9%	2.3%	18,789.05
2018	0.1%	1.4%	39.9%	9.4%	13.2%	17.3%	12.5%	3.9%	2.3%	18,967.07
2019	0.0%	2.3%	41.4%	8.9%	12.5%	16.3%	12.4%	4.1%	2.1%	20,219.97
2020	0.1%	2.2%	43.3%	8.4%	12.1%	15.8%	12.1%	4.0%	2.0%	20,902.17
2021	1.1%	2.2%	42.3%	8.1%	11.8%	15.3%	12.3%	4.9%	2.0%	21,541.90
2022	1.4%	1.9%	43.9%	7.9%	11.7%	14.8%	10.8%	5.8%	1.9%	22,165.10
2023	2.0%	1.7%	43.1%	7.1%	11.3%	14.2%	9.9%	8.4%	2.2%	23,106.00
2024	1.9%	1.6%	43.2%	7.0%	11.2%	14.0%	9.3%	9.3%	2.4%	23,424.00

3.2.2 Historical Demand Growth

The increasing electricity demands for Luzon and Visayas regions from 2014 to 2024 are shown below in Figure 11 and Figure 12. Peak demand is projected to increase at an annual average growth rate of 7% until 2040 which will require significant generation and transmission investment. The role of the price signals and volatility which is a direct function of the WESM price caps is pivotal in ensuring continued efficient investment in the system. By 2040, the Philippines Energy Outlook from 2019 forecasts an additional 50,136 MW for Luzon and 19,195 MW in Visayas are required to meet demand and the overall energy transition requirements.

Figure 11 Historical Luzon Demand Growth

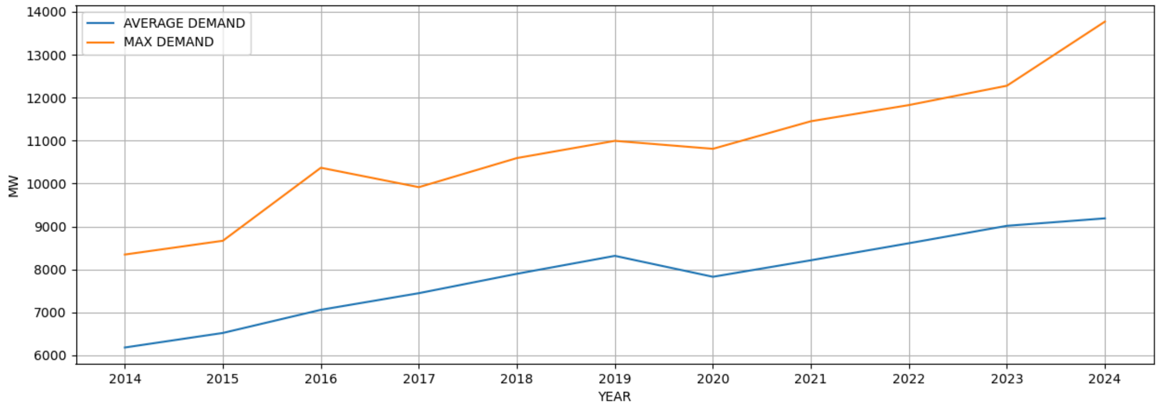
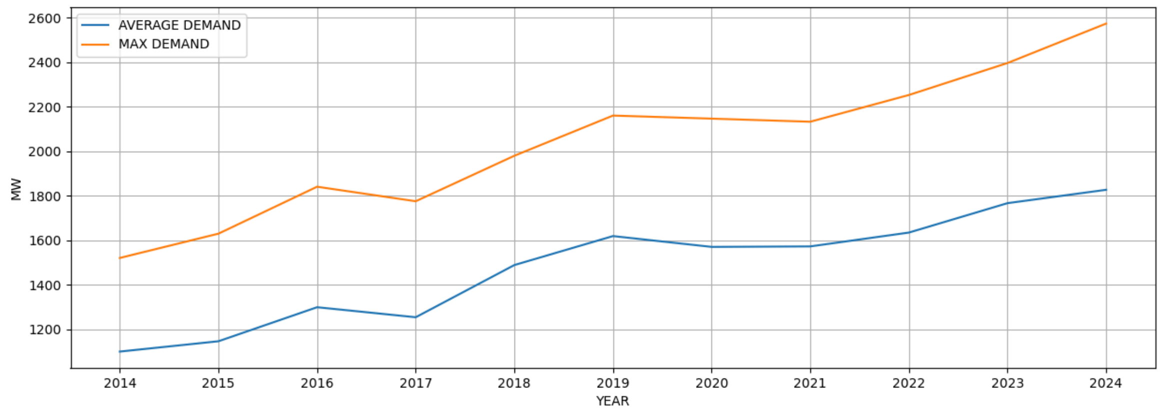


Figure 12 Historical Visayas Demand Growth[51]

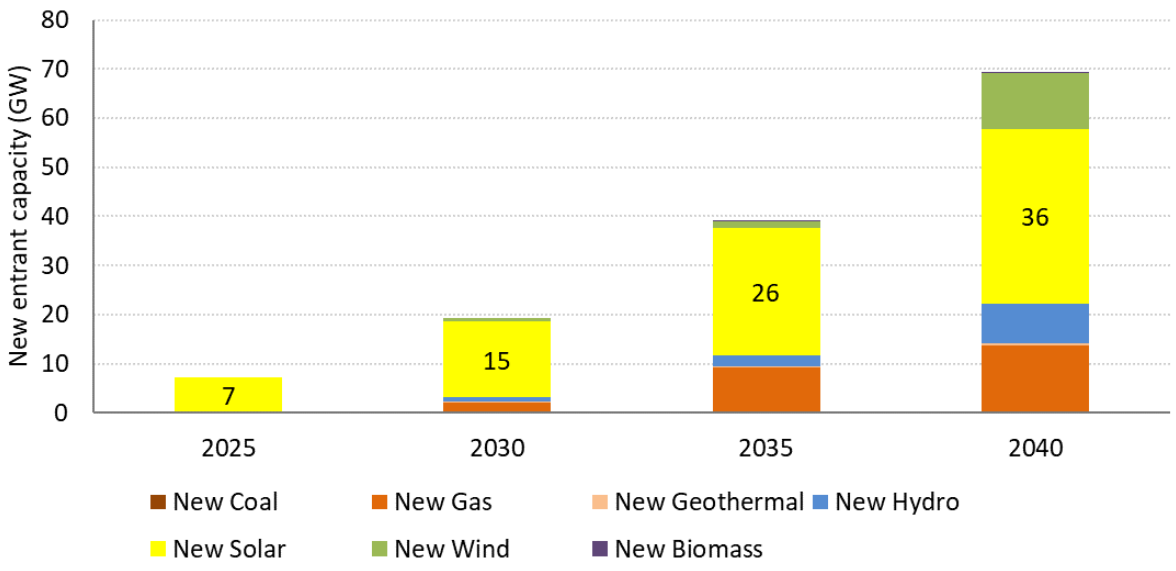


[51] The 2017 Loads Schedule data for Visayas has missing values from February to December and may not accurately reflect the average and peak demand.

3.2.3 Prospective Capacity Investments

Figure 13 plots the expected capacity investments by generation type to 2040 under the 50% RE scenario from Philippines Power Development Plan for 2020-2040.[52] Near- and medium-term capacity investment based on the outlook is primarily comprised of solar, wind with firming gas capacity. Although VRE has a low generation share currently, there is an increasing need to consider solar and wind revenue recovery dynamics. The outlook to 2040, which represents the least-cost pathway, is particularly important as market design parameters, such as price settings, should be set to encourage and incentivise this investment outlook.

Figure 13 Capacity Outlook



3.3 Impact of primary and secondary price cap

3.3.1 Generator-Weighted Average Prices

The WESM is based on locational marginal prices (LMP) to determine the price of electricity at different locations within the power grid. It reflects the cost of delivering the next increment of electricity (typically one megawatt-hour) to a specific location, taking into account the generation costs, losses, and congestion in the transmission system. By definition, volatility can occur in specific network locations which provide economic signals on where to invest in the system to encourage efficient investment.

The assessment and analysis presented here, however, is based on broader market volatility using Generator Weighted Average Prices (GWAP). GWAP is a useful indicator for pricing levels in an electricity market based on LMP and provides a comprehensive view of the market conditions, as it accounts for the varying prices at different locations and the varying output of different generators.

[52] To be updated based on more updated outlook.

3.3.2 Calculation of GWAP

The GWAP is calculated for each interval based on the price associated for the resource and weighted by the generation dispatch. The annual average GWAP is the time weighted average of the GWAP for each region. This is represented by the following formula:

$$GWAP_{ti,r} = \frac{\sum_{g \in G_r} Price_{ti,g} \times Energy_{ti,g}}{\sum_{g \in G_r} Energy_{ti,g}}$$

Where:

$GWAP_{ti,r}$: $GWAP\ for\ time\ interval\ ti\ in\ region\ r$

g: $generator\ resource\ g$

G_r: $generator\ in\ region\ r$

$Price_{ti,g}$: $Price\ for\ time\ interval\ ti\ and\ generator\ resource\ g$

$Energy_{ti,g}$: $dispatch\ for\ time\ interval\ ti\ and\ generator\ resource\ g$

The WESM transitioned from an hourly market to a 5-minute market in the year 2021. The time weighted average for this year is calculated based on the time-weighted average between the hourly and 5-minute market GWAP. The 5-minute market contains the DIPC energy and prices representing the final prices accounting for any market interventions including administered price, secondary price cap and price substitution. However, for the hourly market, the data provided only includes RTD and RTX prices that do not consider the market pricing mechanisms. The nodal RTD and RTX prices are capped between -10,000 Php/MWh and 100,000 Php/MWh to calculate the hourly market GWAP in absence of final settlement values.[53]

The GWAP is the basis of the WESM's secondary price cap.

3.3.3 Calculation of the price cap impacts

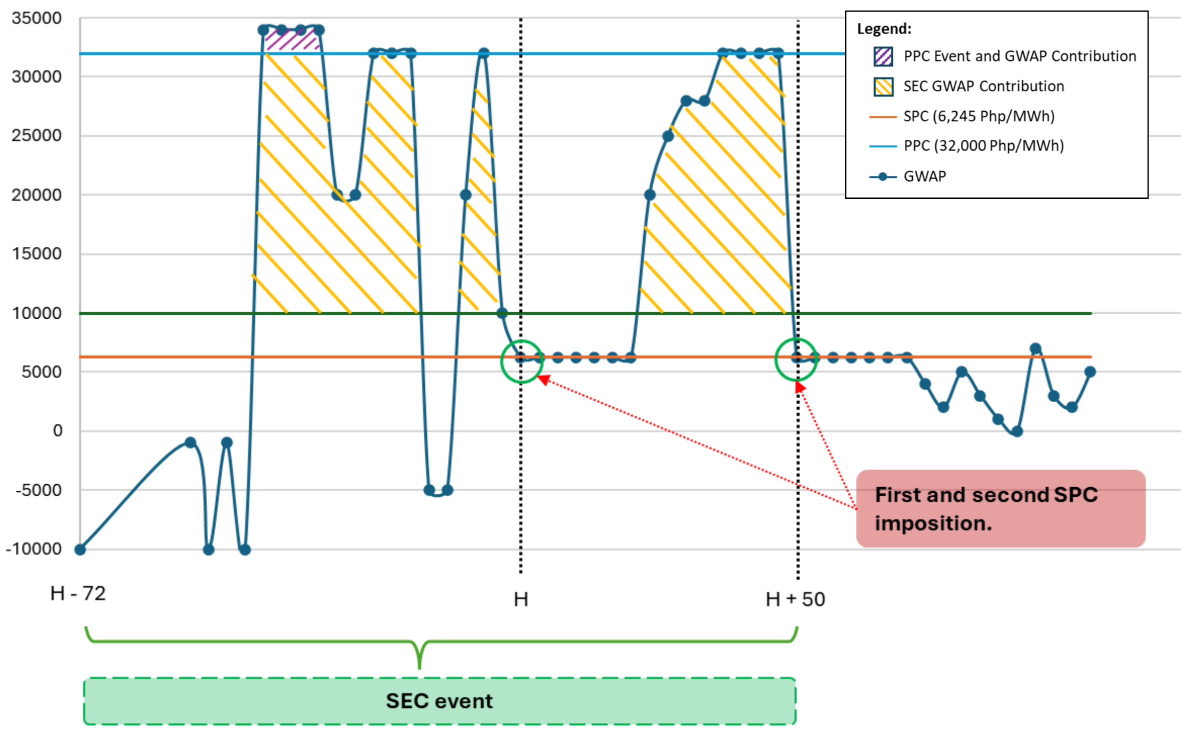
To understand the historical impact of the price caps, the analysis covers the frequency of triggering the caps and the contribution towards the time-weighted GWAP. The price mitigation impact is calculated based on (1) the identification of the event and relevant intervals for primary and secondary price caps, and (2) the contribution of the intervals towards GWAP. Identified intervals relating to the primary price caps are labelled as PPC and those relating to secondary price caps are labelled as SEC. Figure 14 illustrates an example of the relevant periods in the analysis, and the criteria for determining each event and contribution are as follows:

- **PPC event:** An interval is considered a PPC event where the GWAP is equal to or above the PPC value of 32,000 Php/MWh. In this case, the frequency of PPC is the same as the number of PPC events. The rationale for this approach is that a true price cap should apply to the final settlement prices.

[53] The lack of this adjustment results in erroneous outcomes. The price and energy used in calculating the GWAP is based on the RTD for when no market mechanisms are applied and based on adjusted RTX values using the PEN status as the indicator for when pricing interventions occur.

- **PPC contribution:** The contribution of PPC is calculated based on the incremental nodal price above the PPC value of 32,000 Php/MWh. The PPC contribution is weighted by generation dispatch, consistent with the calculation of GWAP.
- **SEC event:** A SEC event is defined as the continuous period starting 3-days prior to the actual SEC flag condition up to and including the last interval flagged with the SEC condition. Non-contiguous periods less than 3-days apart are considered as the same SEC event. The number of SEC events would be smaller than the frequency of SEC flags raised.
- **SEC contribution:** The SEC contribution is calculated based on SEC relevant intervals which includes the preceding 3-day period resulting in the triggering of SEC. The price contribution of SEC is calculated as the difference between the nodal price and 10,000 Php/MWh weighted by the generation dispatch.[54] In situations where the nodal price is also above the PPC, the nodal price is capped to 32,000 Php/MWh to avoid double counting of price impacts. Note that the intervals with SEC flags raised is not considered as the prices in these intervals are below the 10,000 Php/MWh limit.

Figure 14 Relevant Periods in the Price Analysis



[54] 10,000 Php/MWh is used as a threshold in determining the pricing impact.

3.3.4 Frequency of intervals relevant to PPC, SEC and MPF

The frequency of GWAP above the PPC of 32,000 Php/MWh and the number of intervals (standardised to 5-minutes) with SEC flag are shown in Figure 15 and Figure 16 for Luzon and Visayas respectively. The frequency of PPC only includes intervals where the GWAP in the region sits at or exceeds the PPC. The number of intervals of PPC peaked in 2014 at 6% of the year for Luzon and has remained less than 2% for Luzon and Visayas for all other years.

The imposition of SEC trended equally in Luzon and Visayas, with SEC being triggered in 2014 but not between 2015 and 2018. The year 2020 also did not have any SEC related periods due to pandemic impacts. In 2022, the number of SEC intervals exceeded 25,000 representing 25% of the year due to demand growth drivers and impacts on fuel prices from the Ukraine-Russia war and Indonesian Coal Ban[55]. The increase in SEC-related intervals beginning in 2021 is also linked to the shortening of the cumulative threshold horizon to 3 days. While the current secondary price cap has been effective in mitigating sustained high prices compared to the previous years, the prevailing opinion[10] still stands that the current price caps are too low and discourages investments in peaking generators, and potentially solar and wind generation. Furthermore, the PPC intervals averaging at 2% annually is also relatively high as compared to the National Electricity Market in Australia, where the prices only reached its market price cap only 0.1% of the intervals from 2022-2024.

[55] Annual Market Assessment Report 2022 (17 August 2023)

Table 11 summarises the data in the charts and includes the frequency as a percentage of the year as well as the number of SEC events as defined in Section 4.3.3.

Figure 15 Luzon Frequency at PPC and SEC

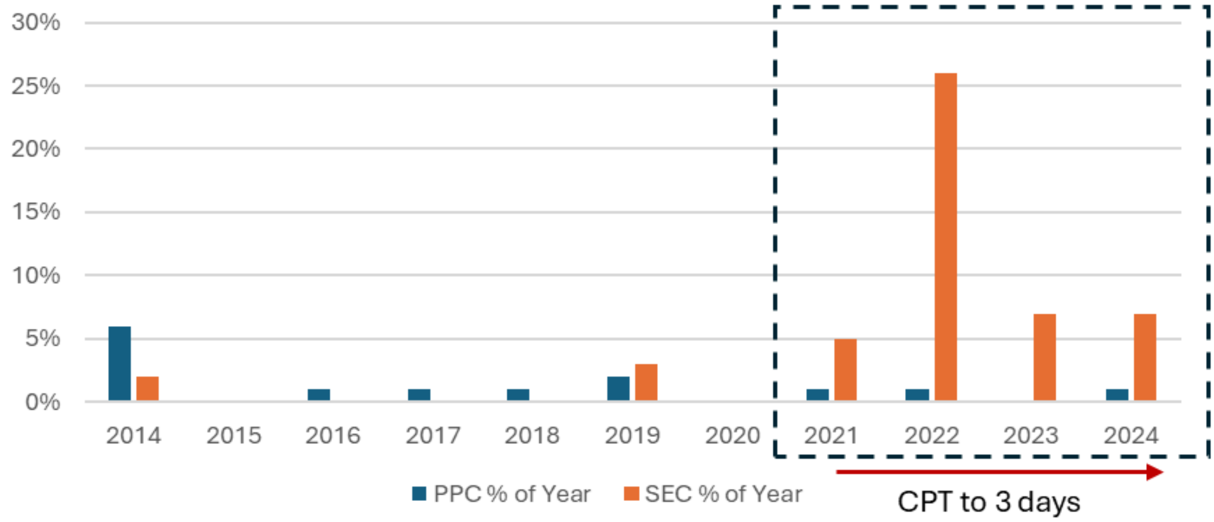


Figure 16 Visayas Frequency at PPC and SEC

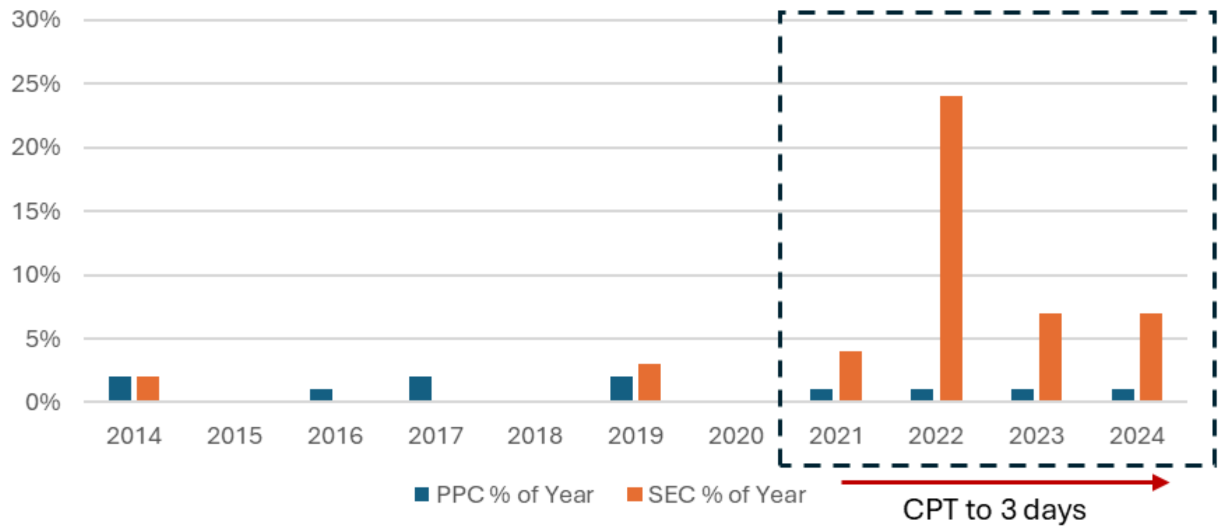
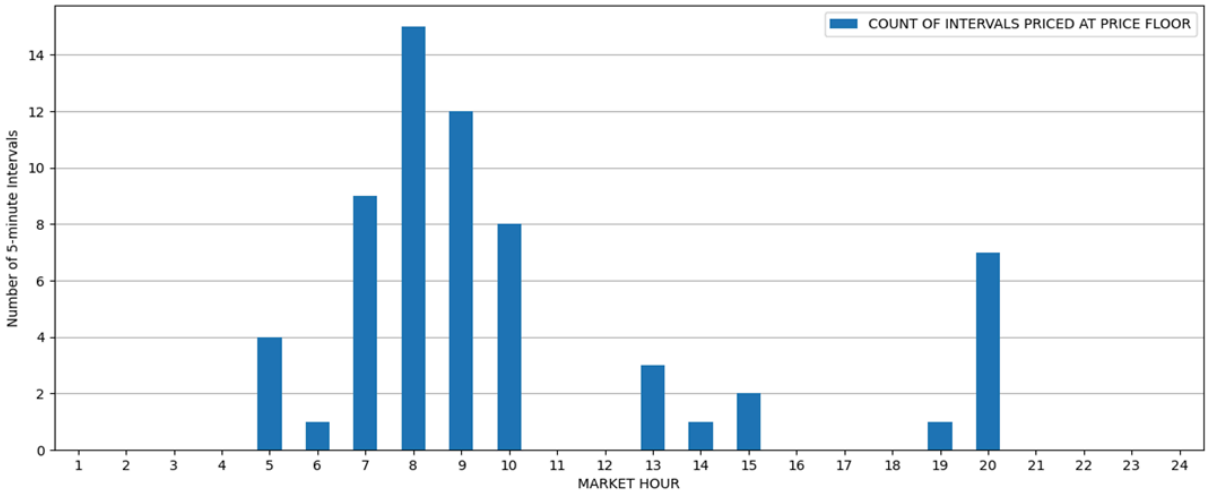


Table 11 Frequency of Relevant Intervals

Region	Year	PPC % of Year	SEC % of Year	SEC Events	MCAP % of Year	MFLOOR % of Year
Luzon	2014	6%	2%	6	6%	0%
	2015	0%	0%	0	0%	0%
	2016	1%	0%	0	1%	0%
	2017	1%	0%	0	1%	0%
	2018	1%	0%	0	1%	0%
	2019	2%	3%	4	2%	0%
	2020	0%	0%	0	0%	0%
	2021	1%	5%	11	1%	0%
	2022	1%	26%	11	1%	0%
	2023	0%	7%	8	0%	0%
	2024	1%	7%	2	1%	0%
Visayas	2014	2%	2%	6	2%	0%
	2015	0%	0%	0	0%	0%
	2016	1%	0%	0	1%	0%
	2017	2%	0%	0	2%	0%
	2018	0%	0%	0	0%	0%
	2019	2%	3%	4	2%	0%
	2020	0%	0%	0	0%	0%
	2021	1%	4%	10	1%	0%
	2022	1%	24%	10	1%	0%
	2023	1%	7%	10	1%	0%
	2024	1%	7%	2	1%	0%

The number of periods in which the GWAP is at the market price floor is much more infrequent at less than 100 intervals per year constituting less than 0.1 percent annually. Figure 17 shows the distribution of intervals at market price floor, grouped in an hourly basis. The intervals with GWAP priced at -10,000 Php/MWh and below were found to occur mostly during hours of solar generation. This implies that with the increasing penetration of solar generation combined with the coal-fired baseload volumes, an increase in the occurrence of market price floor could potentially be seen in these hours and should be considered in implementing future policies in the WESM.

Figure 17 Frequency of Intervals at MPF (Luzon and Visayas, 5-minute market)



3.3.5 Historical Market Prices

Figure 18 and Figure 19 plots the GWAP across the historical period for Luzon and Visayas respectively. The GWAP is split into contribution from prices above the primary price cap of 32,000Php/MWh labelled as PPC, and intervals associated with secondary price cap labelled as SEC. The base component refers to the remaining GWAP not related to PPC or SEC related intervals.

GWAP peaked in 2014 above 8,000 Php/MWh in Luzon and then declined and stabilised around the 4,000 Php/MWh level from 2015 to 2018. The GWAP significantly decreased in 2020 due to demand impacts and normalised post 2020. In 2014, the PPC contribution was the highest amounting to 2,711 Php/MWh out of the total GWAP of 8,346 Php/MWh. The contribution of PPC was up to 10% between 2015 and 2019 and reduces from 2020 to less than 2% of total GWAP as prices were not significantly above the price cap. Visayas, on the other hand, posted its highest Annual Average GWAP in 2022 amounting to 7,614 Php/MWh. This was followed by years 2023 and 2019 at 6,505 Php/MWh and 5,125 Php/MWh respectively. Meanwhile, the highest recorded contribution of prices influencing PPC in Visayas occurred in 2017 amounting to 27.5% of the total annual average GWAP or equivalent to 918 Php/MWh. Following are the years 2014 and 2016 with 20% and 10% contributions to the annual average GWAP, respectively.

In 2020 and between 2015 and 2018, there were no imposition of SEC in both regions. On the other hand, year 2022 saw the most intervals with SEC. Sustained high prices during the rainy season of 2022 led to the imposition of the SEC for 26% of the total market intervals for the year in Luzon and 24% in Visayas.

Typhoon Odette/Rai brought significant destruction affecting most parts of Visayas (regions 6, 7, and 8) and region 4B in Luzon by the end of 2021. As a result, Visayas posted the highest number of intervals with administered prices from December 2021 until early 2022 due to the damages in the transmission system. Disturbance in supply import from Visayas elevated the prices in Luzon which then triggered secondary price caps in Luzon until January 2022.[56]

[56] Philippines: Typhoon Rai (Odette) - Emergency Appeal No. MDRPH045 - Final Report. https://reliefweb.int/report/philippines/philippines-typhoon-rai-odette-emergency-appeal-no-mdrph045-final-report

From 2014 until 2022, Visayas region experienced sustained high prices mostly during the rainy season, with 69% of the affected intervals occurring between June and November. Similarly, 64% of the market intervals with SEC in Luzon also occurred during the rainy season. The seasonal trend changed in the past year with 89% of the total market intervals with SEC occurred between February and May in both Luzon and Visayas regions. Prices influencing SEC in Luzon and Visayas had the highest contribution to the annual average GWAP in the past three years. In 2022, SEC events contributed 13% to the annual average GWAP in Visayas while 2021 and 2023 posted 7% and 6%, respectively. Similarly for Luzon, SEC events contributed 11% to the annual average GWAP while 2021 and 2023 posted 8% and 5%, respectively.

Figure 18 **Luzon Historical Annual Average GWAP**

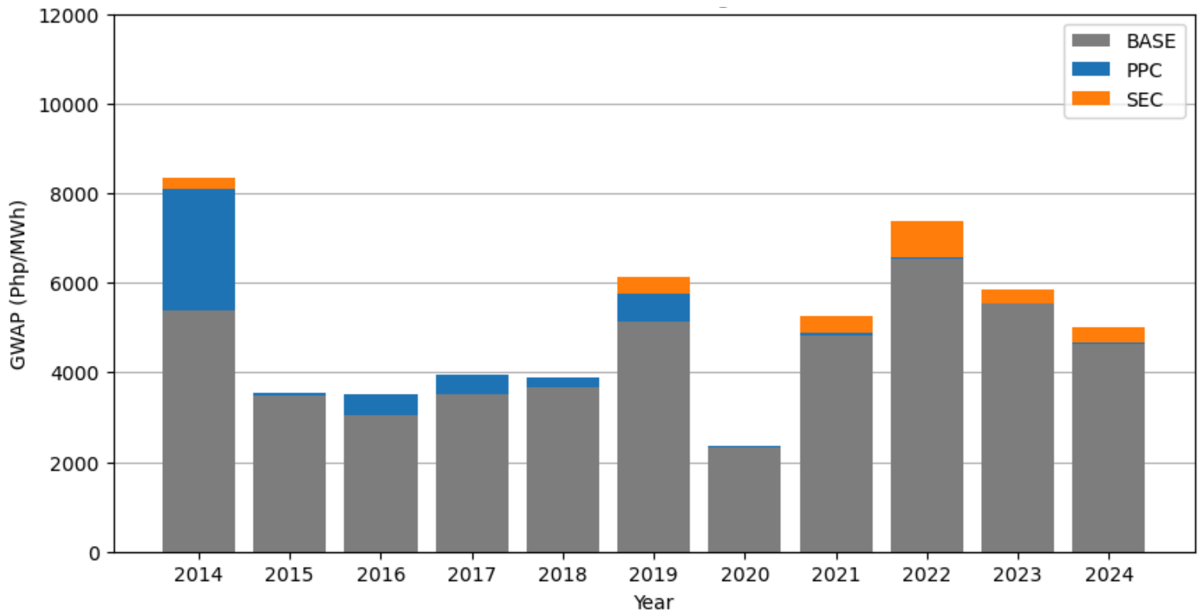
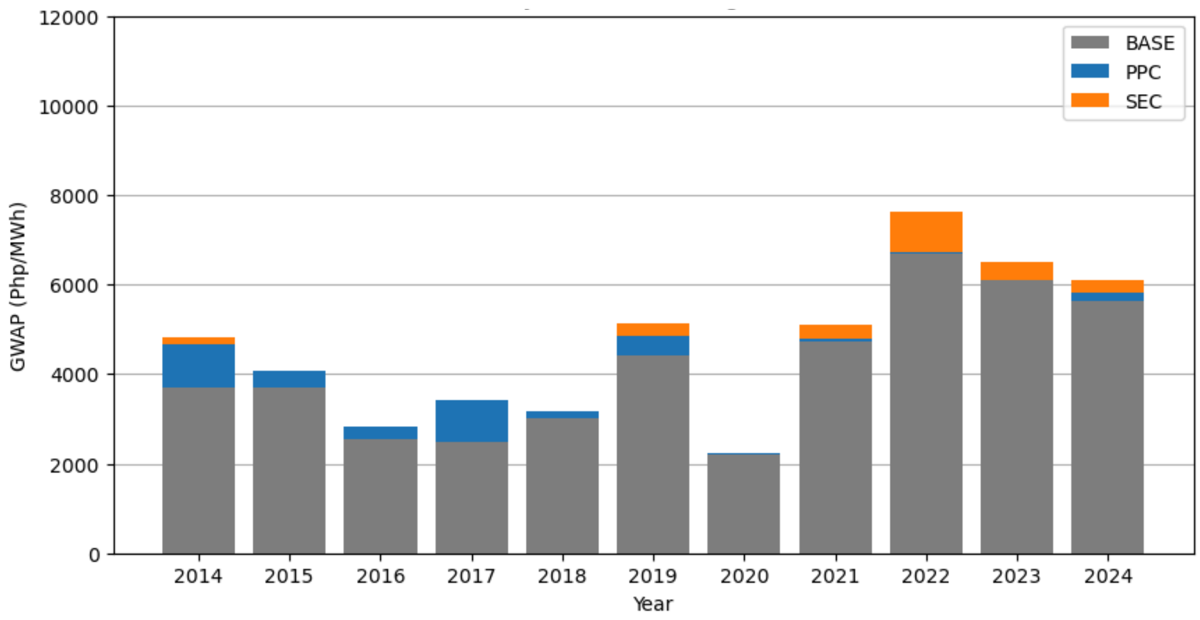


Figure 19 Visayas Historical Annual Average GWAP



3.3.6 Distribution of GWAP

Figure 20 and Figure 21 plots the price duration curve (log base 10) of GWAP values for Luzon and Visayas respectively.[57] There is significant price volatility in the years 2014 to 2019 for both Luzon and Visayas with a considerable proportion of GWAP above the PPC of 32,000 Php/MWh. The pandemic impact in 2020 resulted in lower prices across the distribution curve as seen in the red curve at lower levels. Almost 20% of prices were below 1 Php/MWh in 2014 and 2017 years for Visayas. Higher capacity and generation of solar and wind introduced from 2020, and the transition from an hourly market to 5-minute settlement as shifted the distribution of GWAP in both Luzon and Visayas. The frequency of high prices has decreased; however, prices are generally higher across the board between the 20 to 90 percentiles.

The price distribution near the price floor has not changed in Luzon, however, in Visayas, there is lower proportion of prices near the price floor.

[57] Prices were capped at 100,000 Php/MWh, see Section 0. The y-axis is floored at 1 Php/MWh due to the log scale.

Figure 20 Price Distribution Curve - Luzon

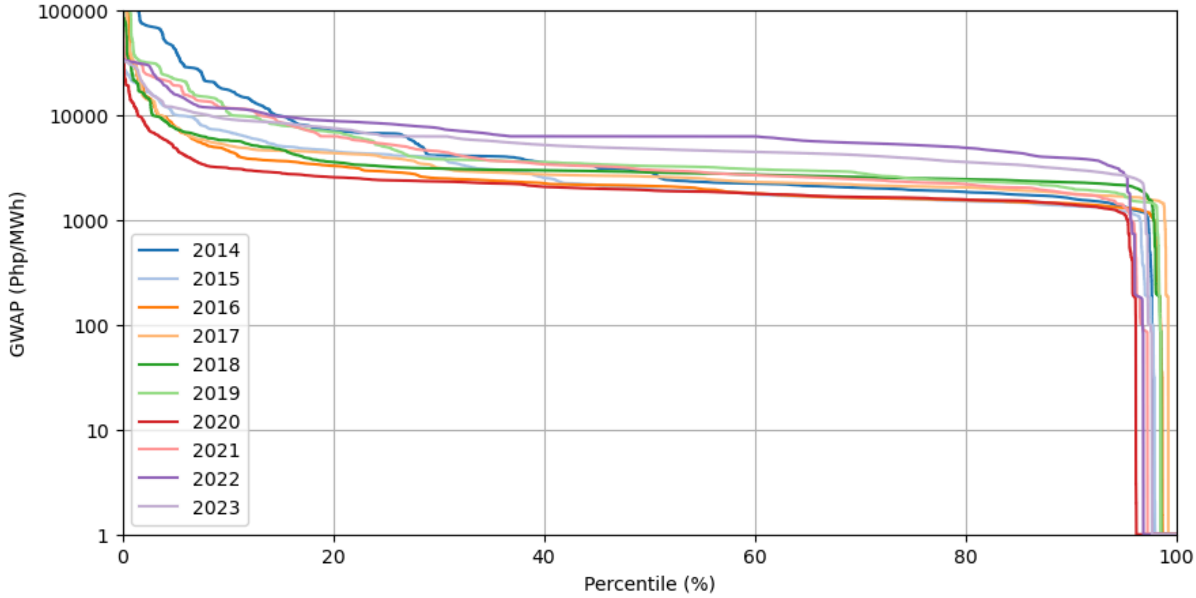
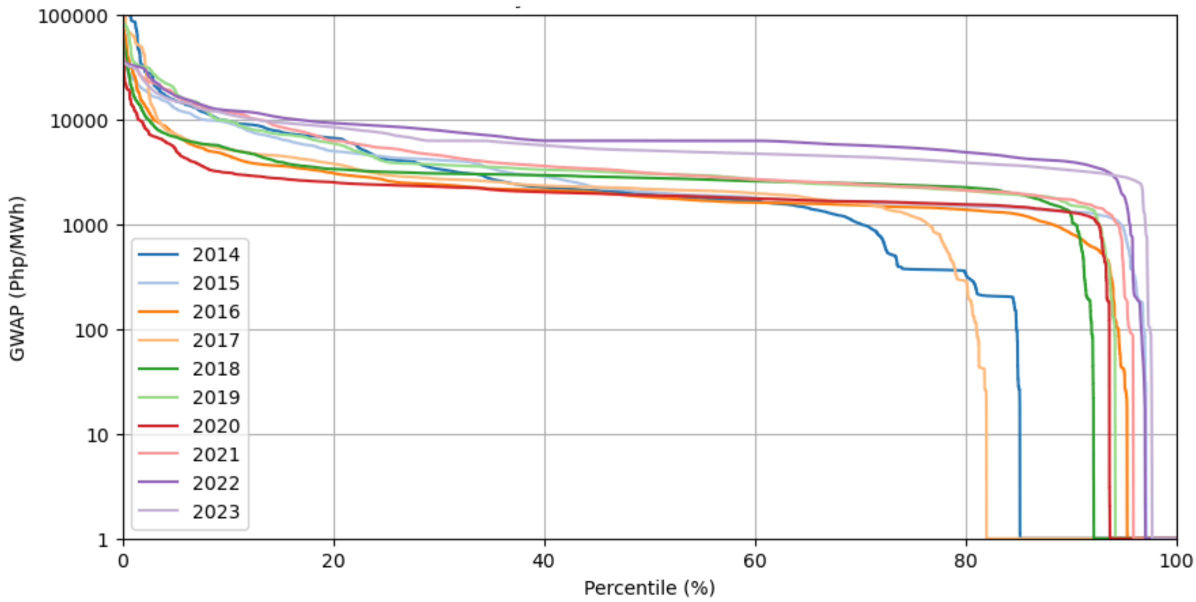


Figure 21 Price Distribution Curve - Visayas



3.4 Factors Driving Primary and Secondary Price Caps

This analysis explores the conditions under which Primary and Secondary Price Cap scenarios arise to provide additional context for any changes to the existing price caps.[58] The identified factors influencing high prices include demand, renewable energy generation, outages, and bidding behaviour. The method to classify high-price events are summarised in Table 12 below and are based on the relevant intervals for PPC and SEC as discussed in Section 4.3.3. Additionally, prices within the

[58] Intervals can include both PPC and SEC flags and therefore the analysis is carried out based on either condition.

PPC and SEC event groups were filtered to include only those higher than or equal to 10,000 Php/MWh, effectively eliminating low-priced intervals that may share similar market conditions with high-priced intervals. The criteria or thresholds for categorising the drivers were determined based on the underlying pricing analysis and judgement, with the aim of categorising most intervals and minimising instances where no category could be assigned.[59]

Table 12 Price Driver Criteria

Price Driver	Grouping	Condition	Description
1. High Demand	Region, Year, Season, Hour	> 70th percentile	To determine whether high-price events are driven by high demand, the total demand for the interval is compared to demands of the similar intervals within the same season of the current year. When the demand for the interval is in the 70th percentile of the population, it is considered a high-demand interval.
2. Low Renewable Energy Generation	Region, Year, Season, Hour	< 30th percentile	Similar with the demand, Low RE generation is determined for the group of similar hours/intervals within the same season of the current year. This is to consider the generation profile of RE, particularly solar plants. If the RE Generation falls below the 30th percentile of the population, then it is considered that Low RE Generation is one of the factors driving high prices.
3. High Outages	Region, Year	> 70th percentile	The outages were determined based on the total capacity on outage per region. To categorise high price events as driven by high outages, the total unavailable capacity for each interval is grouped for each year. If the capacity on outage is in the 70th percentile of the group, then the high-price event is treated to be influenced by the high outages.
4. High Bids	Region, Year, Season	> 70th percentile	A threshold of 10,000 Php/MWh was initially set to determine high-priced generation offers. High-priced capacities (i.e., capacities offered above the threshold) were grouped together per season within the same year. In this group, market intervals with high-priced capacities in the 90th percentile were considered as intervals with High Bids.
5. Line Congestion	-	Weighted contribution of congestion cost >= 15% of the GWAP	Based on the currently available data, high prices are identified as being driven by line congestion when the contribution of congestion costs to the GWAP is greater than or equal to 15%. This was established consistent with the percentage of time the price substitution methodology was applied, consistent with the published data in the annual market report.

[59] Where intervals were determined to be impacted by multiple drivers, the interval count would then be equally split across the factors.

Price Driver	Grouping	Condition	Description
6. Others	-	-	With the currently available data, all intervals that do not fall under the categories mentioned above were grouped as "others". This may include market-related and grid-related events (e.g. market intervention).

Figure 22 shows the frequency of the individual factors influencing PPC and SEC since the transition of the WESM to a 5-minute market. Market intervals with high prices were found to be driven mostly by high demand, accounting for 23.9% of the total intervals, and closely followed by high outages, high offer prices, and low RE generation at 19.6%, 19.2%, and 18.8%, respectively.

Figure 23 shows the split between factors driving PPC and SEC, separately. From the charts, PPC is mostly influenced primarily by high demand and high outages accounting for 38% and 26% of the total intervals, respectively. Similarly, factors influencing SEC were found to be driven mostly by high demand as well, accounting for 24%. Moreover, the factors influencing SEC mostly determines the overall distribution of price drivers as PPC intervals are comparatively less than SEC intervals.

Low renewable energy generation accounts for between 13% and 19% of these intervals. However, given the historically low share of variable renewable energy (VRE) generation, its impact on pricing and volatility is likely to have been minimal. Nevertheless, the coincidence of these conditions with Primary Price Caps (PPC) and Secondary Price Caps (SPC) provides valuable insight into potential issues with intermittent generation. As RE penetration in the market increases, low intermittent RE generation issues are expected to be more prevalent (see Section 4.5). Therefore, policies regarding price caps should not only incentivise investments in renewable energy generators but also support the development of firming generation technologies, such as battery energy storage systems, peaking gas plants, and pumped storage.

Figure 22 Frequency of Price Drivers influencing PPC and SEC (5-minute Market)

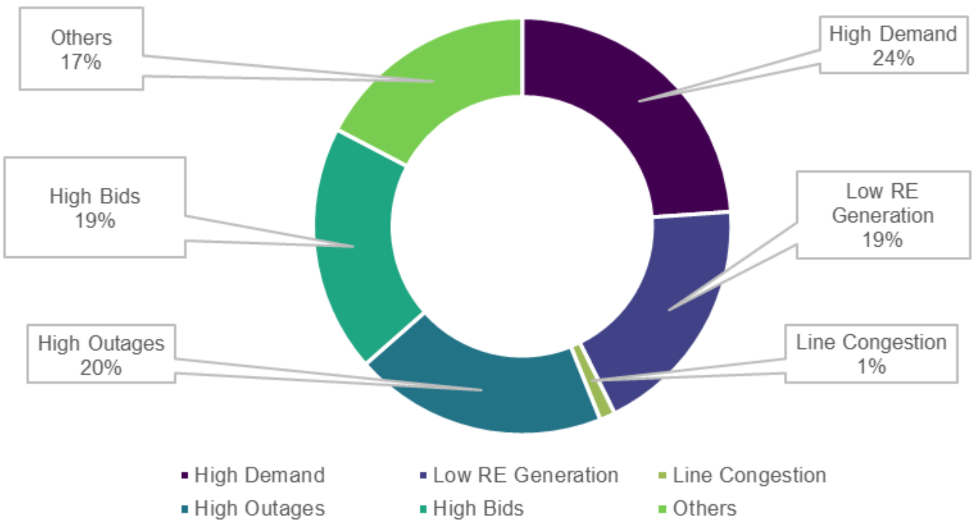
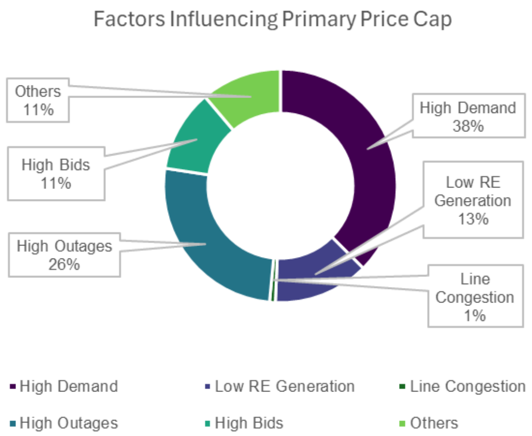
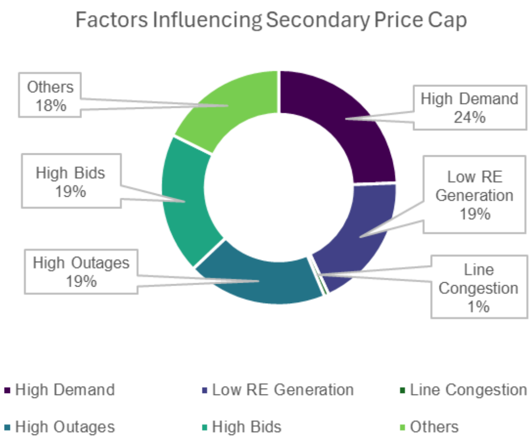


Figure 23 Price Driver Frequency Split between PPC and SEC (5-minute Market)





3.5 Example pricing impacts from high VRE

Figure 24 and Figure 25 show the power generation data in South Australia and New South Wales, respectively, to provide a baseline of the actual price volatility in electricity markets with varying shares of renewable energy. A large portion of the electricity demand in South Australia is primarily sourced from wind energy while New South Wales is not as heavily dependent to VRE. Although the shares of VRE on both regions vary largely, the price volatility on both regions resulted from the ramp limitations or lower dispatchable capacity of VRE during the evening peak intervals. In line with the investment outlook and the identified frequency distribution of price drivers in Section 4.4, low intermittent RE generation issues could potentially increase along with increasing RE penetration in the WESM. This supports the idea that the future amendments to the price mitigation measures should be forward-looking and should strike a balance between encouraging investments in renewable energy generators, as well as investments into firming generation technologies.

Figure 24 Price Impacts from High Renewable Energy (South Australia)

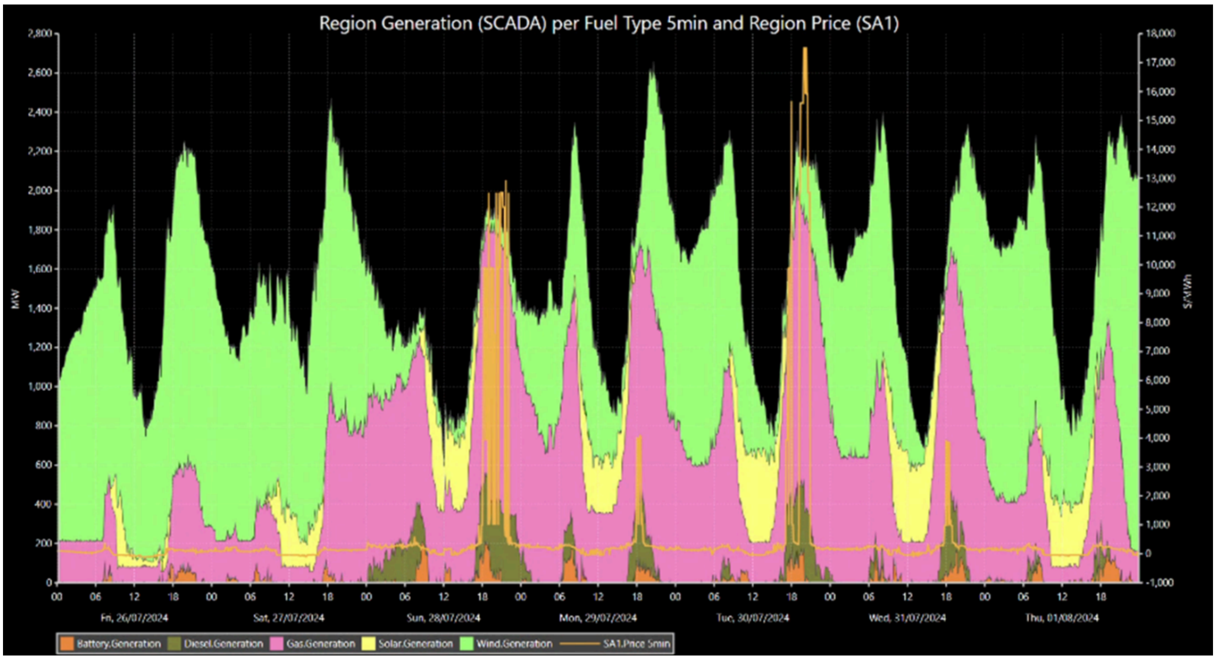
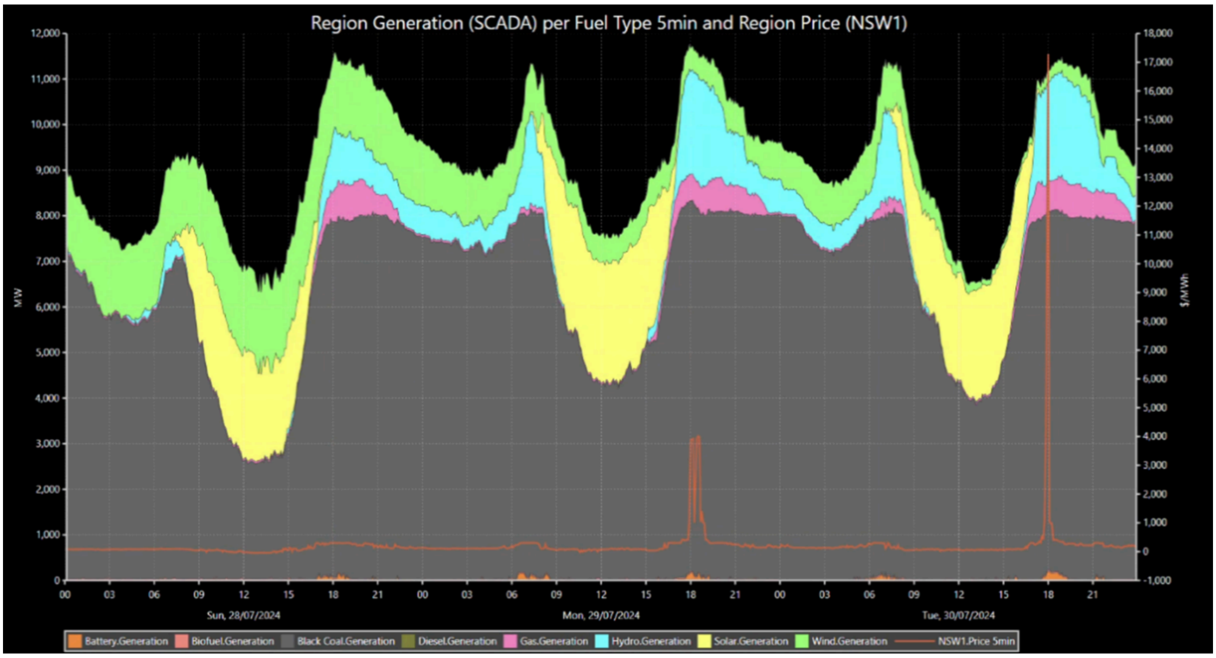


Figure 25 Price Impacts from High Renewable Energy (New South Wales)



3.6 Key findings

GWAP has exceeded the Primary Price Cap on average 1% throughout the 10-year period. Although the annual time-weighted impact of PPC has been low in the recent years, the frequency is high, and prices can significantly exceed 32,000 Php/MWh. On the other hand, market price floor continues to be triggered very rarely and would not need to be revised at this point in time, however, it should be monitored with increasing VRE penetration in the WESM.

Since the transition to the 5-minute market, the frequency of SEC events in Luzon and Visayas increased significantly more due to underlying conditions combined with the shortening of the CPT period to 3-days. This potentially undermines generation investments as the caps would most likely set the price instead of the market.

Finally, the WESM will experience significant growth in VRE investment primarily solar PV generation in the short to medium term outlook. Price settings should be set to encourage and incentivise the target investment outlook. However, based on the above findings, high prices driven by low RE generation issues can be expected to increase along with increasing intermittent renewable energy penetration. As such, price caps should also be set to encourage investment into firming generation technologies such as BESS, peaking gas, pump storage.

The key findings are summarised in Table 13 below.

Table 13 Key findings

Analysis	Market Condition	Findings
Frequency	Market Price Cap	The frequency of market price cap was greatest in 2014 for Luzon at 5,844 5-minute intervals equating to 5.56% of the year, whereas in Visayas for the same period, there were only 2148 5-minute intervals of market price cap. The frequency of market price cap trended similarly for Luzon and Visayas from 2015 to 2024 ranging from 0.4-2.0% The PPC intervals averaging 1% annually is relatively high compared to the National Electricity Market (NEM) in Australia, where the PPC occurs on average only 0.1% of the intervals from 2022-2024.
	Market Price Floor	Since the start of the 5-minute market in 2021, the intervals with GWAP priced at -10,000 Php/MWh and below were found to occur during hours of solar generation but has been very infrequent. However, the frequency of triggering the market price floor should be monitored with continued penetration of VRE (particularly solar plants) combined with coal-fired must-run volumes.

Analysis	Market Condition	Findings
	Secondary Price Cap	Year 2022 saw the most intervals with SEC. Sustained high prices during the rainy season of 2022 led to the imposition of the secondary price cap for 26% of the total market intervals for the year in Luzon and 24% in Visayas. The increase in SEC-related intervals beginning in 2021 is also linked to the shortening of the cumulative threshold horizon to 3 days.
Contribution to GWAP	Primary Price Cap Events	For Luzon, year 2014 posted the highest contribution of prices influencing PPC amounting to 32.5% of the total annual average GWAP equivalent to 2,712 Php/MWh. Following are the years 2016 and 2017 with 13% and 11% contributions to the annual average GWAP, respectively. For Visayas, it was in year 2017 which had the highest contribution of prices influencing PPC amounting to 27.5% of the total annual average GWAP equivalent to 918 Php/MWh. Following are the years 2014 and 2016 with 20% and 10% contributions to the annual average GWAP, respectively.
	Secondary Price Cap Events	In the past three years, prices influencing SEC had the highest contribution to the annual average GWAP of Luzon and Visayas. For Luzon in 2022, SEC events contributed 11% to the annual average GWAP while years 2021 and 2023 posted 8% and 5%, respectively. For Visayas, SEC events contributed 13% to the annual average GWAP in year 2022 while years 2021 and 2023 posted 7% and 6%, respectively.
Price Drivers	High Demand	High demand was the primary factor influencing both SEC and PPC events since 2021. This accounted for 24% of the total market intervals since the transition of WESM to the 5-minute market.
	Low RE Generation	Low RE Generation comprises 18.8% of the total high-priced intervals related to PPC and SEC. This ranks 4^{th} among the most frequent factors influencing high-prices since 2021.
	High Outages	High Outages ranks 2^{nd} among the factors influencing PPC and SEC events in the WESM.

Analysis	Market Condition	Findings
	High Bids	Generator quantities offered at higher prices share 19.2% of the total market intervals relevant to PPC and SEC. This ranks 3rd among the most frequent factors driving high market prices.
	Line Congestion	Intervals with high congestion costs only share 1% of the total intervals related to PPC and SEC.
	Others	High-priced intervals that do not fall under the categories above comprises 17.3% of the total number of intervals.

4 WESM Price Mitigation Revenue Impacts

Reforms of the WESM price caps should encourage efficient investment in future generation requirements but also consider commercial outcomes across existing generation investments under the context of regulatory stability. The assessment of historical generator revenues addresses the potential revenue risk for updating the existing price cap settings in the WESM. The historical analysis covers spot revenue outcomes across generation assets in the WESM relating specifically to PPC and SEC intervals. The analysis presented here is to present the revenues earned from periods impacted by the price caps. The aggregate revenue relating to the PPC and SEC calculated here corresponds to the total revenues at-risk subject to prospective reforms to the WESM price caps.

4.1 Calculation of Generator Spot Revenues

Generator spot revenues represent the potential revenue change due to adjustments to the price mitigation measures. The generator revenues are based on the relevant PPC and SEC intervals identified in Section 4.3.3. The generator spot revenues here are the gross revenue received from the spot market and do not include third party contracts which will affect the analysis.[60] The revenues are calculated differently for the hourly and 5-minute market as there are different reported prices in the market trading data described in the formulas below. The RTD and RTX prices used to calculate revenues are consistent with the price assumptions covered in Section 4. The spot revenues are calculated at the nodal level using nodal prices and then summed for each generation type.

For hourly market: $Revenue_{ti} = Price_{RTD} \times Energy_{RTD} + Price_{RTX}\left(Energy_{RTX} - Energy_{RTD}\right)$

For 5-minute market:

$$Revenue = Price_{DIPC} \times \frac{Energy_{DIPC}}{12}$$

4.2 Spot Revenue Impacts

4.2.1 Revenue Composition Summary

Prior to 2018, multiple resource types received significant revenue streams relating to PPC, however, the contribution of PPC has declined as the frequency of PPC events has dropped. In contrast, the greater frequency of SEC intervals in the recent four years have seen greater increases in revenue streams relating to volatility associated to SEC periods. Figure 26 shows the trend of the average contribution to gross spot revenues of PPC and SEC events.

[60] Data still outstanding.

Figure 26 Average Contribution to Gross Spot Revenues

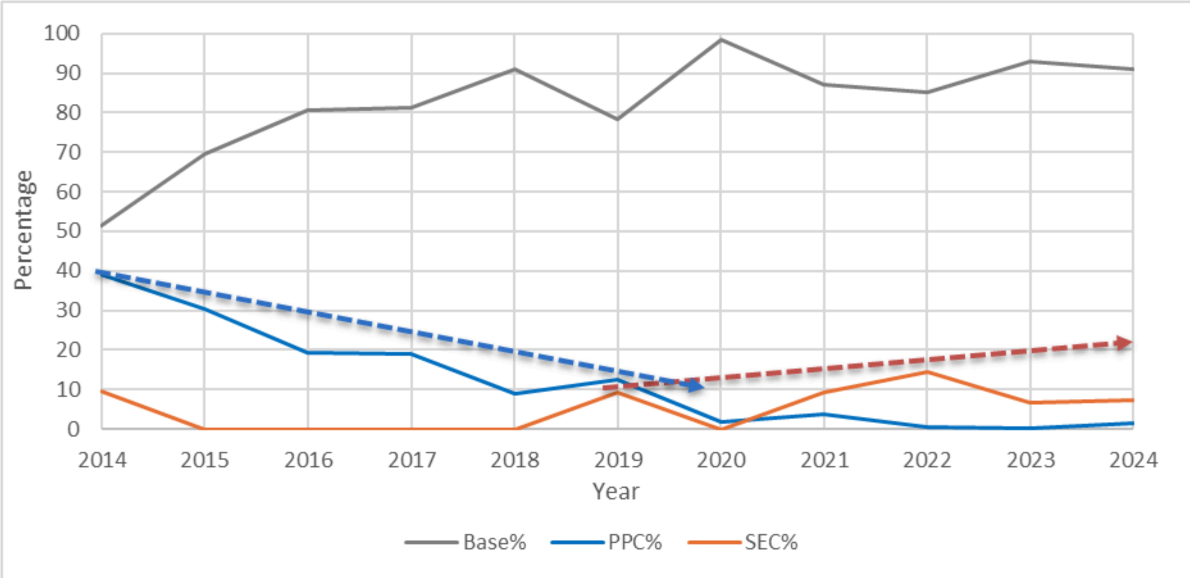
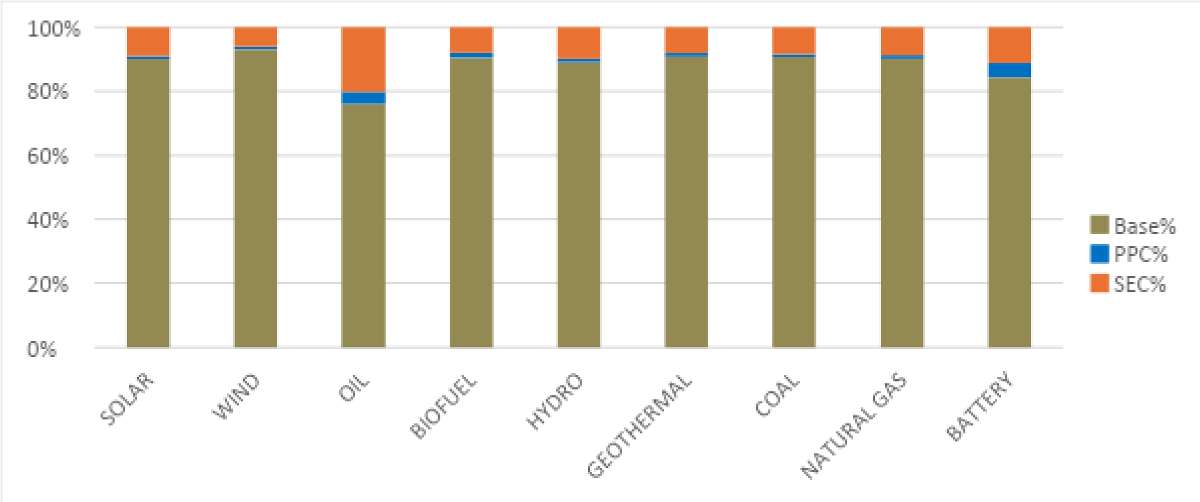


Figure 27 illustrates the breakdown of gross spot revenues over the past five years. Variable renewable energy resources, such as solar and wind, earned the majority of their revenue outside of Primary Price Cap and Secondary Price Cap intervals, averaging over 90% in these periods. In contrast, fuel-based resources had a similar revenue distribution but typically received higher revenues from PPC and SEC intervals compared to their renewable counterparts. Revenues from PPC and SEC constitute a much more substantial portion of net revenues after accounting for fuel costs. Thus, adjusting the current price settings would have a more significant impact on non-VRE generators than on VREs, particularly in terms of meeting fixed costs, and this consideration should also be included in any potential reform.

Implementing a price cap that applies to final settlement values could result in potential revenue losses. However, these losses would likely be more than offset by the proposed changes to the secondary price cap.

In general, price caps should be designed to support future investment while avoiding significant negative impacts on the feasibility of existing generators, unless that outcome is intentional. In Australia, recent policies led to the accelerated retirement of coal-fired power plants, creating system security challenges. As a result, some state governments have had to implement incentive schemes to keep coal plants operational during the energy transition, ensuring stability as the country shifts towards a more sustainable energy mix.

Figure 27 Breakdown of Gross Spot Revenues per MW (2019 – 2024)



4.2.2 Revenues by Category

The annual revenue standardised per MW are reported in Figure 28 and Figure 29 for Luzon and Visayas respectively.

The revenue received per MW follows the same trends with the base GWAP as VRE generally do not receive prices in excess of the PPC. The VRE revenues averages 10 million Php per MW, however, there are some years in Visayas where the revenues are considerably less. This occurred where the RTX energy schedule was less than the RTD energy schedule resulting in negative spot revenues. The spot revenues attributed to SEC relevant intervals only represent a small percentage of gross revenue and VRE resources in recent years do not receive revenues where the prices are above the PPC. This means that the potential revenue loss from changes to the price mitigation measures are less than 6% of gross revenues.

Figure 28 Luzon VRE Revenue per MW

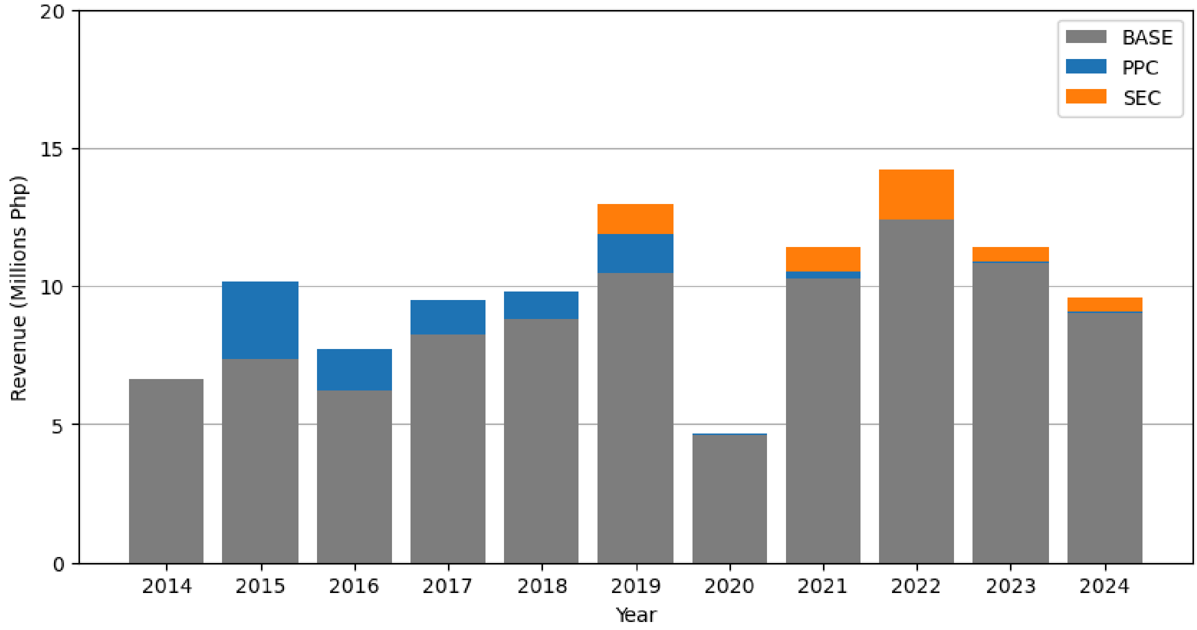


Figure 29 Visayas VRE Revenue per MW

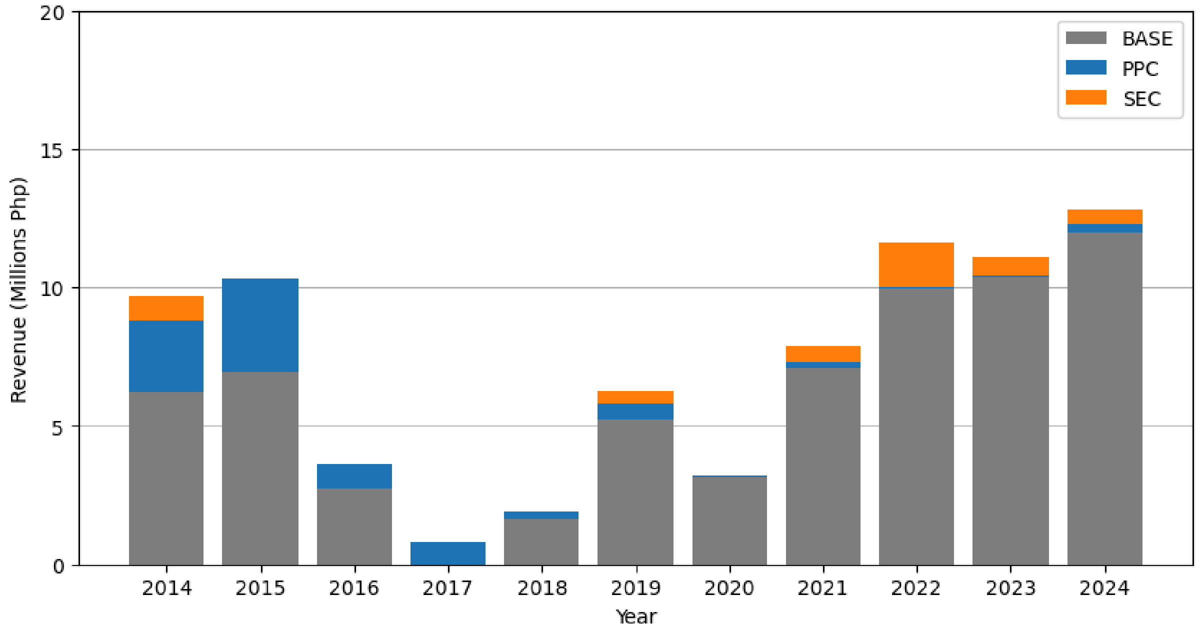


Figure 30 and Figure 31 plots the gross energy revenues for non-VRE generators per MW of capacity for Luzon and Visayas respectively. The revenues shown here are the gross spot market revenue and does not include contracts and does not consider costs. The spot market revenue received from prices above the primary price cap was significant in 2014 at more than 50% of total revenues. The value of PPC revenues decreased from 30% to 10% in 2015 to 2019, and from 2020 PPC revenues represent a minor component of total revenues. Spot revenues attributable to SEC relevant intervals were 11% in 2014, and average 9% in the last 4 years. Further investigation would be required to determine the impact of changes to SEC as the revenues could be considered a significant component of net revenues.

Figure 30 Luzon Non-VRE Revenue per MW

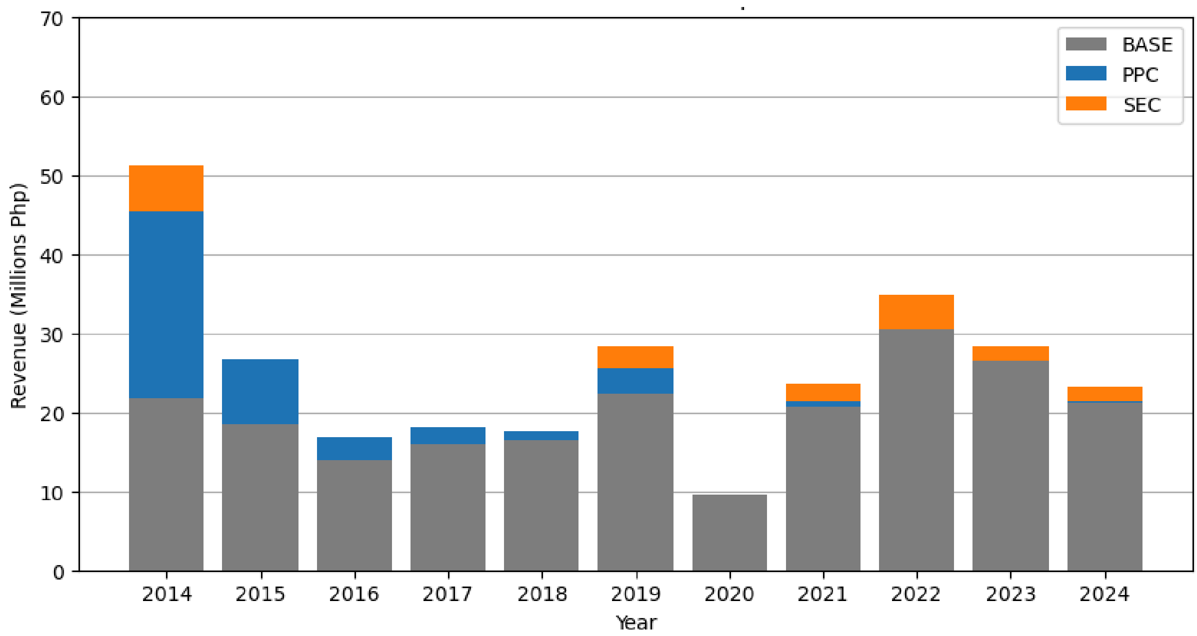
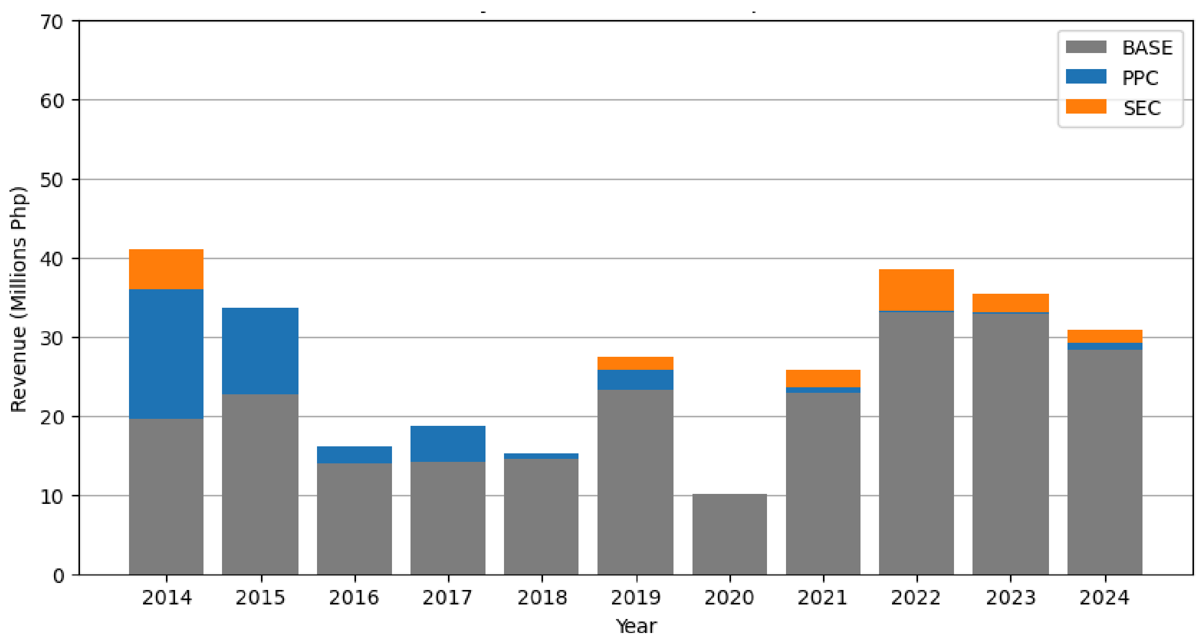


Figure 31 Visayas Non-VRE Revenue per MW



4.2.3 Revenue by Plant Type

Table 14 shows the spot market generator revenue for each resource type standardised by capacity. The difference in revenue between resource types reflects differences in nodal prices at each resource and is also driven by capacity factor of the plant type. The annual revenues trend approximately with annual average GWAP, with the maximum revenue achieved in 2014 corresponding to the highest recorded annual GWAP across the system. Natural gas, coal and geothermal received the highest average annual revenue across the time period at above 30 million Php per MW of installed capacity. Renewable resources including wind and solar received around 10 million Php per MW of installed capacity. In the recent period, wind has generated 40% higher revenues per MW than solar.[61]

Table 15 tabulates the share of revenue generated during PPC and SEC relevant intervals as a proportion of total annual spot revenues. In 2014, most plant types received significant revenues above 30% consistent with contribution to GWAP from PPC in the year. Subdued prices from pandemic impacts in 2020 resulted in lower revenues for all generation types resulting in limited revenue arising from PPC and SEC. Prior to 2018, multiple resource types received significant revenue streams relating to PPC, however, as the frequency of PPC has dropped, PPC has presented as less significant. In contrast, the greater frequency of SEC intervals in the recent four years have seen greater increases in revenue streams relating to SEC. Variable renewable energy resources including solar and wind earns the majority of their share of revenue outside of PPC and SEC intervals at above 90% on average since the transition to 5-minute dispatch and settlement market. Fuel based resource types had similar revenue splits but generally received higher PPC and SEC revenues compared with renewable counterparts. Potential changes to revenue loss from enforcing price caps would be considered minor and the increase of revenue by reducing applications of secondary price caps would cover the revenue reductions.

Table 14 Revenue per MW (Million Php)

Type	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
SOLR	14.30	13.33	5.22	3.10	4.92	8.82	3.58	8.96	12.42	10.40	9.09
WIND	6.40	9.53	7.20	7.48	8.69	12.58	5.04	12.63	15.70	13.94	14.54
OIL	32.98	11.91	7.27	7.67	3.82	11.19	1.23	6.18	8.26	3.43	4.62
BIOF	8.93	7.46	10.47	12.15	10.77	13.59	5.64	12.31	18.30	14.30	17.66
HYD	24.73	10.89	8.54	10.68	9.93	14.23	4.54	11.29	13.66	13.10	9.47
GEO	50.13	34.03	19.30	18.48	19.83	32.50	13.15	28.31	41.64	37.63	32.06
COAL	63.44	35.97	21.18	23.76	21.91	34.47	13.29	31.34	44.08	35.40	31.25
NATG	72.67	42.13	23.78	24.30	27.35	46.87	14.12	32.22	40.01	29.90	28.21
BAT	0.00	0.00	2.37	1.66	9.36	23.76	4.11	1.98	0.09	0.00	0.13

Table 15 Revenue Split

Type	Rev Split	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
SOLR	Base%	55.6	58.6	72.8	57.3	84.8	76.2	98.4	87.5	86.1	94.0	93.7
	PPC%	32.6	41.4	27.2	42.7	15.2	14.1	1.6	3.2	0.3	0.1	0.4
	SEC%	11.8	0.0	0.0	0.0	0.0	9.7	0.0	9.3	13.6	5.8	5.9

[61] Revenue metric is not standardised to capacity factor.

Type	Rev Split	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
WIND	Base%	99.5	75.0	85.7	92.4	94.7	88.0	99.3	93.8	88.7	96.5	94.4
	PPC%	0.5	25.0	14.3	7.6	5.3	6.5	0.7	1.3	0.3	0.1	1.9
	SEC%	0.0	0.0	0.0	0.0	0.0	5.5	0.0	5.0	11.0	3.3	3.8
OIL	Base%	29.4	51.0	68.6	64.7	81.6	64.4	92.4	73.6	74.7	80.0	78.2
	PPC%	57.6	49.0	31.4	35.3	18.4	20.8	7.6	9.3	1.0	0.9	3.8
	SEC%	13.0	0.0	0.0	0.0	0.0	14.8	0.0	17.1	24.2	19.0	18.0
BIOF	Base%	49.5	89.1	82.6	85.7	92.9	82.2	99.2	90.0	86.9	93.8	91.8
	PPC%	44.3	10.9	17.4	14.3	7.1	10.8	0.8	3.0	0.5	0.3	2.8
	SEC%	6.3	0.0	0.0	0.0	0.0	7.0	0.0	6.9	12.7	5.8	5.3
HYD	Base%	44.1	72.9	78.8	82.6	90.7	73.3	98.6	87.0	82.1	95.1	93.6
	PPC%	45.4	27.1	21.2	17.4	9.3	15.8	1.4	3.2	0.4	0.1	0.6
	SEC%	10.5	0.0	0.0	0.0	0.0	11.0	0.0	9.8	17.5	4.7	5.8
GEO	Base%	45.7	69.9	86.0	88.2	94.9	81.8	99.3	89.1	87.5	94.2	93.0
	PPC%	42.7	30.1	14.0	11.8	5.1	10.6	0.7	3.1	0.4	0.2	1.3
	SEC%	11.6	0.0	0.0	0.0	0.0	7.6	0.0	7.8	12.1	5.6	5.7
COAL	Base%	46.3	70.2	85.7	85.9	95.5	82.2	99.8	88.3	88.1	94.6	92.5
	PPC%	42.7	29.8	14.3	14.1	4.5	9.4	0.2	3.3	0.1	0.1	0.7
	SEC%	11.0	0.0	0.0	0.0	0.0	8.4	0.0	8.4	11.8	5.3	6.8
NATG	Base%	41.4	70.4	84.5	92.4	92.6	78.0	99.6	87.1	88.2	94.8	91.8
	PPC%	46.7	29.6	15.5	7.6	7.4	11.7	0.4	3.7	0.2	0.1	0.5
	SEC%	11.9	0.0	0.0	0.0	0.0	10.3	0.0	9.2	11.6	5.1	7.8
BAT	Base%	0.0	0.0	12.6	65.5	92.6	78.4	100.0	86.6	81.2	0.0	52.4
	PPC%	0.0	0.0	87.4	34.5	7.4	11.0	0.0	4.1	0.4	0.0	13.3
	SEC%	0.0	0.0	0.0	0.0	0.0	10.6	0.0	9.3	18.3	0.0	34.3

4.2.4 Revenue Adequacy

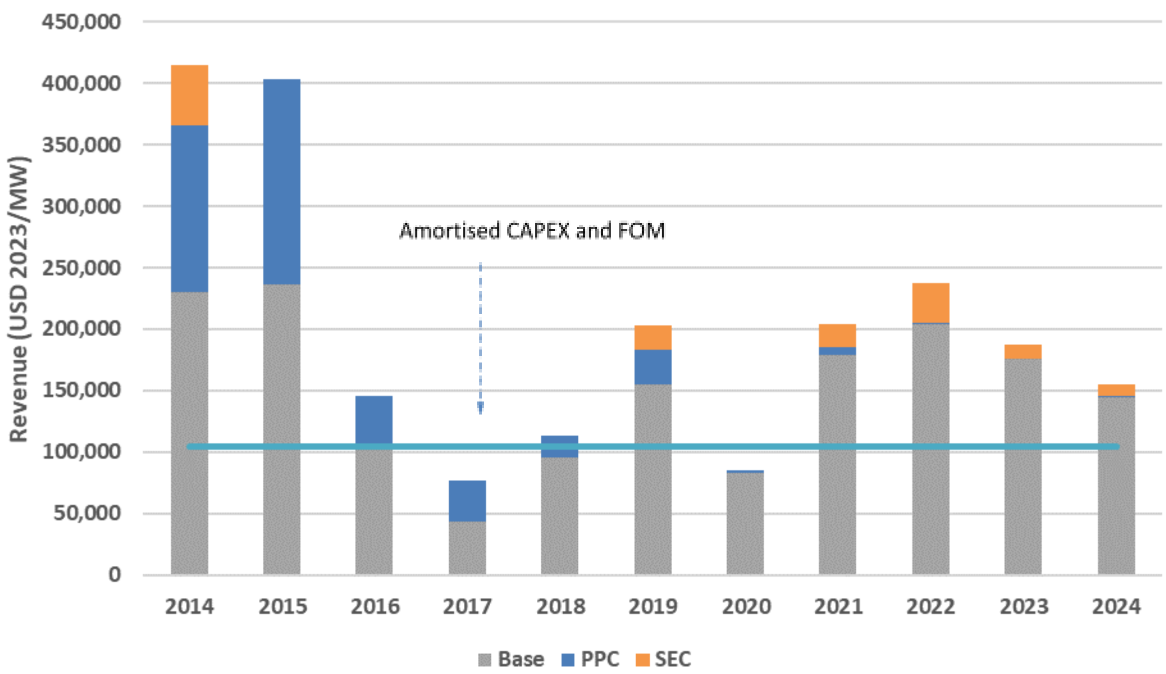
Figure 32 and Figure 33 plots the revenue per MW against the sum of amortised capex and FOM represented by the horizontal line for solar and wind respectively. The revenues are spot market revenues and have not included renewable energy certificate revenues. Solar has recovered their fixed costs from base revenue in 8 of the 11 years. More recently, both solar and wind have recovered their fixed costs in the past 4 of the 5 years. At a high level, investments in solar and wind would continue to be incentivised by WESM pricing conditions outside of PPC and SEC intervals. However, caution should be exercised regarding the following and highlights the importance of forecasting revenue conditions or setting price caps based on forward projections.

- Whether high fuel prices that currently support base revenues are likely to persist in the future.

- The impact of increased variable renewable energy (VRE) penetration, particularly for solar investment, as generation is concentrated during the middle of the day, which could drive prices lower.

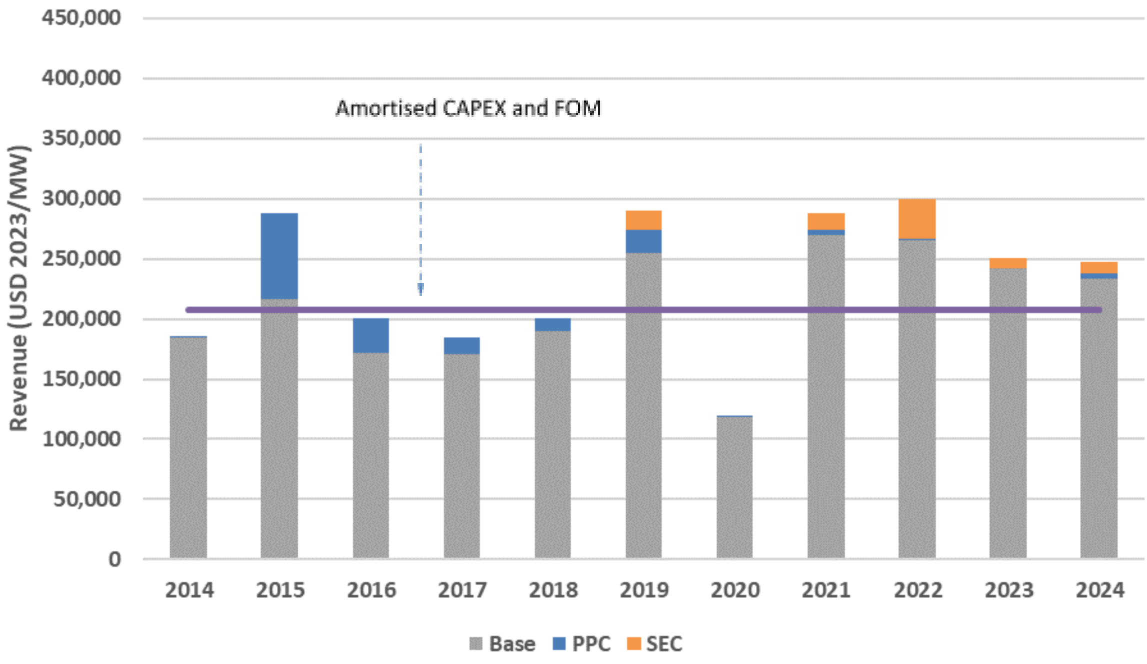
In general, price caps should be designed to support future investment while avoiding significant negative impacts on the feasibility of existing generators, unless that outcome is intentional. In Australia, recent policies led to the accelerated retirement of coal-fired power plants, creating system security challenges. As a result, some state governments have had to implement incentive schemes to keep coal plants operational during the energy transition, ensuring stability as the country shifts towards a more sustainable energy mix.[62]

Figure 32 Solar Revenue Adequacy



[62] https://www.energy.nsw.gov.au/nsw-plans-and-progress/regulation-and-policy/agreement-eraring

Figure 33 Wind Revenue Adequacy



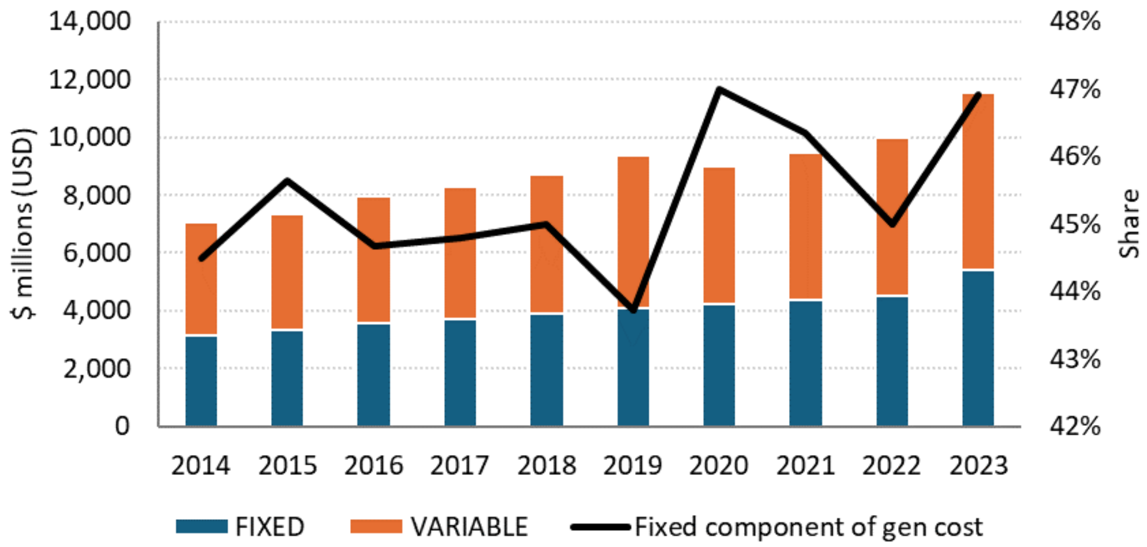
4.3 Cost structures in the WESM

The costs structure of the WESM, the split across variable (fuel and VOM) and fixed (amortised capex and FOM) components of cost, is important in the context of the WESM price cap settings. This is due to the energy-only design of the WESM whereby generators need price volatility, or periods of tight supply, to recover its fixed costs. As seen in Section 4.3.6, prices across the year are generally much closer to short-run marginal costs, and without a capacity payment, generators would otherwise be unable to recover fixed costs. Any sustainable electricity market, and by extension the design and pricing parameters, must allow for generators to adequately recover its cost.

Historical analysis of the WESM costs, as illustrated in Figure 34, shows a cost base increasing in line with serving growing demand growth, however, the fixed component is also generally increasing with a step up from 2020. One factor driving this is the increasing renewable energy capacity in the WESM, which generally only has fixed costs. As RE penetration increases, this trend would be expected to continue.

The implication of such a change is that the WESM price settings need to allow for a growing share of fixed cost recovery. In the case of solar and wind, where generation spot revenues do not depend as much on price volatility, the case can be made that the recovery of capex for VRE would need to be considered with alongside firming technologies such as battery energy storage systems as integrated portfolios, i.e., battery energy storage systems would have to recover fixed costs obligations of the portfolio.

Figure 34 Annual costs by component in the WESM



Note: The analysis is based on 2030 generator cost assumptions from the Vietnam Technology Catalogue 2023. All cost assumptions have been fixed, mainly to remove the impact of changing fuel prices over time.

4.4 Key findings

Adjustments to the price mitigation measures should strike a balance between protecting consumers from high tariffs whilst attracting new investments and commercial outcomes across existing generation portfolios.

Revenues for variable renewable energy plant types averaged approximately 10 million Php per installed MW of capacity, compared to about 30 million Php per installed MW for base load generation such as coal, geothermal, and natural gas. The revenue split from Primary Price Cap and Secondary Price Cap influenced by the frequency of these events, with SEC-related revenues increasing in recent years. Since the introduction of 5-minute settlement, solar and wind resources have generated over 90% of their revenues from intervals not related to PPC and SEC. PPC has been limited to less than 1%, meaning a fixed price cap would have a negligible impact on renewable generation types. Enforcing price caps on settlements would have minimal effect on existing revenues due to the low number of binding intervals. Increasing the SEC period would enhance revenues, as SEC revenues have risen in recent years.

Conversely, the impact on fuel-consuming generation types is less clear, as gross revenue does not accurately reflect net profit. Rule changes to PPC and SEC could represent up to 12% of gross revenue but may constitute a higher proportion of net profits. Given these considerations, PPC and SEC settings are more critical for fixed cost recovery for fuel-based generation.

Potential revenue losses from capping settlement prices to the price cap would likely be more than offset by the proposed change to the Secondary Price Cap. SEC revenues constitute a significant portion of net revenues (after fuel costs) for non-variable renewable energy plants and should be factored into any updates to price settings.

Although base revenues over the past 5-years has delivered revenue adequacy for solar and wind plants, the historical outcomes should be treated with caution and price settings should be forward-looking to account for the potential persistence of high fuel prices supporting base revenues and the impact of increased VRE penetration on revenues.

As the share of fixed costs within the WESM cost structure increases, this trend is expected to continue with rising RE penetration. The Primary Price Cap and SEC are crucial for fixed cost recovery in WESM, given that it operates as an energy-only market.

5 Key findings

The Philippine Wholesale Electricity Spot Market has greatly evolved since it began its commercial operations in 2006. Due to the sustained high prices in the past, policies including Offer Price Caps, Offer Price Floor, and Secondary Price Cap have been put in place to control prices while setting a competitive environment among the market participants. These price settings and other WESM rules ensure generator revenue adequacy, promote efficient investment, and minimise end-user costs, which are the core objectives of the WESM. The Primary Price Cap (PPC) only applies to the generator offers which results to the market prices exceeding the set price cap. In contrast, the Secondary Price Cap (SPC) is applied to the final market prices, directly influencing the market outcomes. These price settings were derived from the operational costs, capital expenditures, and investment costs at the time they were implemented. The level of the market price caps is still imposed in the present market and has not been adjusted since 2015.

The cost structure of the WESM is likely to shift with higher RE generation targets. Increased volatility is expected from rising intermittent generation resources, leading to a growing need for peaking or firming generation options over time. The analysis and review carried out here would support a review of the current methodology of setting the price caps, and for the values to be updated in line with the WESM's supply outlook.

International Review of Price Mitigation Measures

- There is currently no quantitative measure of reliability in place. An explicit reliability standard should be established, which will, in turn, guide the setting of overall price cap levels. A formal comprehensive rule change to introduce a reliability framework and the setting of price caps could take up to several years.
- The principles and processes for setting price caps are not well-defined. The WESM lacks a robust framework comparable to that in the Australian NEM.
- The existing price cap settings have been based on a traditional energy mix and have not been updated to support the ongoing energy transition within the WESM.
- Unlike other markets, the WESM applies caps and floors only to bids, rather than to final energy and reserve prices.

WESM Price Trends

- Price settings should be designed to support the increased presence of variable renewable energy (VRE) in the WESM outlook.
- The frequency of triggering the Primary Price Cap (PPC) is high, and prices can substantially exceed 32,000 Php/MWh. Similarly, the frequency of triggering the Secondary Price Cap (SPC) has increased significantly due to the reduction of the Cumulative Price Threshold (CPT) period to three (3) days. This situation may potentially discourage investment in generation

particularly those with high fixed costs, as the current SPC sets the market prices but has not been updated to align with the current economic conditions.

- The secondary price cap imposition is mainly influenced by the high demand, high outages, and high generator offers over the past 10 years. Intervals associated to the SPC have had higher contributions on the annual average GWAP since the transition of the WESM to a 5-minute market. This is not only due to the reduced rolling average period, but also because of the high prices that tend to manifest due the intermittent imposition while there are sustained high prices brought by prevailing market conditions such as high demand and high outages.
- While the market price floor does not require revision at this time, conditions should be closely monitored as VRE penetration grows. The impact of high prices driven by low renewable energy generation is expected to rise with increasing VRE penetration. Therefore, price caps should also incentivise investment in firming generation technologies, such as battery energy storage systems (BESS), peaking gas plants, and pumped storage.

Price Mitigation Revenue Impacts

- Potential revenue losses from capping settlement prices to the price cap would likely be more than offset by the proposed change to the Secondary Price Cap. SEC revenues constitute a significant portion of net revenues (after fuel costs) for non-variable renewable energy plants and should be factored into any updates to price settings.
- As the share of fixed costs within the WESM cost structure increases, this trend is expected to continue with rising RE penetration. The Primary Price Cap (PPC) and SEC are crucial for fixed cost recovery in WESM, given that it operates as an energy-only market.
- Price settings should be forward-looking to account for the potential persistence of high fuel prices supporting base revenues and the impact of increased VRE penetration on revenues.