

nems



ANNIVERSARY

# MARKET REPORT 2023

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## 2023 AT A GLANCE



Total registered capacity of generators  
 ⚡ **3.6%** to  
**13,015MW**



**11** new facilities were added in the market



**2** new wholesale market traders and  
**1** new retailer joined the market



Electricity consumption  
 ⚡ **0.9%** to  
**55.0TWh**



Generation supply  
 ⚡ **3.4%** to  
**7,127MW**



Annual value of products traded  
 ⚡ **13.2%** to  
**\$15.47 billion**



Registered capacity of IGS facilities  
 ⚡ **108.3%** to  
**825MW**



Demand Response curtailment capacity  
 ⚡ **43.4%** to  
**76MW**



Demand Response payment  
 ⚡ **33.0%** to  
**\$28.4 million**



Average Uniform Singapore Energy Price (USEP)  
 ⚡ **15.2%** to  
**\$247.52/MWh**



Combined market share of top three generation companies fell to  
**51.3%**



Market share of SP Services  
 ⚡ **4.2%pt** to  
**29.6%**

# ENERGY MARKET COMPANY: LETTER FROM THE CHAIRMAN

## Dear Industry Members

### NEMS 20<sup>th</sup> Anniversary Celebrations

What a year it has been for the industry! We celebrated the 20<sup>th</sup> anniversary of the National Electricity Market of Singapore (NEMS) with a slew of events reminiscing the development of the market since its opening in 2003.

From the liberalisation of the electricity market and privatisation of generation companies to the launch of demand side management programmes and adoption of renewable energy, the evolution of NEMS has been pivotal in supporting Singapore's successes.

We kicked off the celebrations with the launch of the anniversary logo in January and ended the year with a NEMS community event in November, planting 100 trees in support of Singapore's OneMillionTrees movement.

During the year, we also launched a new NEMS website to better engage users, organised the popular Singapore Electricity Roundtable and gathered everyone for what was arguably the most memorable event, the NEMS 20<sup>th</sup> Anniversary Gala Dinner.

For the first time, we also commissioned a commemorative book to showcase key milestones over the last two decades from the perspectives of past and present colleagues at Energy Market Company (EMC) and the Energy Market Authority (EMA).

I am heartened to witness the industry coming together in such a big way and thank everyone for their unwavering support over the last 20 years.

### 2023 in Review

Singapore's GDP grew 1.1 percent, moderating from the growth of 3.8 percent in 2022. Electricity demand continued to grow, albeit at a slower pace, increasing 0.9 percent to 55.0 terawatt hour. Coupled with a drop in generation supply to 7,127 megawatts (MW), this brought about the normalisation of tighter supply cushion conditions in the market in 2023.

The average Uniform Singapore Energy Price (USEP) was relatively stable, falling 15.2 percent to \$247.52 per megawatt hour (MWh). EMC will continue to work with EMA to explore, consult and execute enhancements that stabilises the market.

There was a slight dip in the annual value of products traded in the wholesale electricity market to \$15.47 billion, from its peak in 2022.

Last year, we partnered EMA to launch the Demand Side Management Regulatory Sandbox and organised several forums to introduce demand side management programmes to businesses. We believe that demand side management has lots of potential for growth as it benefits both the power system and businesses by stabilising electricity prices during times of tight supply and incentivises businesses for cutting down on their electricity usage.

I am glad to share that in this first year of the two-year regulatory sandbox, while there were fewer periods with demand response curtailment, the total load capacity and curtailed load increased 43.4 percent and 28.4 percent respectively. Participating companies received a total of \$28.4 million in incentive payments. EMC will continue to work with EMA to explore ways to encourage more businesses to participate in the demand side management programmes.

This year, households can also actively reduce their electricity consumption by taking part in EMA and SP Group's pilot Residential Demand Response programme. The programme is slated for launch in the second half of 2024.

I am also encouraged that five new Intermittent Generation Sources facilities entered the market in 2023, bringing the total registered capacity to 825MW. Singapore's installed solar capacity surpassed one gigawatt-peak (GWp) in the first half of 2023 and these new renewable resources will keep Singapore on track to meet the goal of 1.5GWp of solar deployment by 2025. EMC has been working with EMA to provide solar forecasts to predict solar power generation throughout the day and mitigate the impact of solar intermittency.

## ENERGY MARKET COMPANY: LETTER FROM THE CHAIRMAN

### At the Forefront of the Energy Transition

2023 was a year of transition. In the face of ongoing volatility in the global energy markets and the recovery of gas supply, the industry has moved to enhance Singapore's energy security, sustainability and affordability.

On this front, EMA has granted conditional approval for the import of 4.2GW of electricity from Cambodia, Indonesia and Vietnam. This will contribute to Singapore's plans to import up to 4GW of low-carbon electricity by 2035, and support the energy transition

Keppel Sakra Cogen, Sembcorp Industries, YTL PowerSeraya and the relatively new Meranti Power, have also committed to build new hydrogen-ready generation facilities. These facilities can be upgraded in the future to run entirely on hydrogen.

Significantly, EMA introduced the Temporary Price Cap (TPC) and a new vesting regime framework in July to mitigate prolonged high electricity prices and stabilise electricity prices in the market.

In the second half of the year, the USEP averaged \$177.37/MWh, 44.4 percent lower than it had been in the first half as global gas price levels stabilised. TPC was activated on three occasions of elevated electricity prices and helped return prices to normal levels relatively quickly.

The Ministry of Trade and Industry and EMA have also announced plans to set up a new gas company in 2024 to centralise the procurement and supply of gas for the power sector. This will help stabilise gas prices and supply, which will eventually result in stable electricity prices and supply.

### Onwards to the Next 20 Years

The NEMS and the industry have evolved tremendously in the years leading up to our celebration of this important milestone. Over the last two decades, the NEMS witnessed several key milestones, such as the introduction of the first wholesale market trader and embedded generators in 2006 and 2008 respectively, to the launch of the demand response programme in 2016, open electricity market in 2018 and more recently, the first electricity imports and energy storage system in 2022 and 2023.

As Mr Tan Soo Kiang, the first EMC Chairman, expressed in his first letter, the wholesale market structures, rules and systems that have been established are world-class and provide a robust platform for an efficient industry and ongoing evolution.

20 years on and the call for ongoing evolution remains. The challenges brought on by the energy transition are complex. Integrating new renewable energy sources and the development of low carbon solutions will require the market and industry to come together to evolve and innovate. To this end, EMC has been working with the industry to understand the challenges and has continued to enhance the platform to bring about greater market transparency and stability.

The solutions will be complex and may challenge the status quo, but EMC is committed to partnering regulators and industry members to ensure that the market remains competitive and sustainable.

Finally, I want to reiterate my heartfelt appreciation to you for supporting our industry-wide initiatives, and for the trust and confidence that you have placed in us. Let us strive to forge a resilient energy market together.



**Agnes Koh**  
Chairman  
Energy Market Company



# MARKET OVERVIEW

## MARKET OVERVIEW: MARKET HISTORY

The National Electricity Market of Singapore (NEMS) opened in January 2003 – a result of the culmination of several structural reforms to Singapore’s electricity industry.

Singapore’s journey to liberalisation traces back to October 1995, when industry assets were first corporatised. In 1998, the Singapore Electricity Pool, a day-ahead market, commenced operation to facilitate competitive bidding among power generation companies. By 2001, the introduction of a new legal and regulatory framework formed the basis for a new electricity market.

The NEMS is an integral part of Singapore’s overall energy policy framework, which seeks to balance the three policy objectives of economic competitiveness, energy security, and environmental sustainability. The NEMS places Singapore alongside an international movement to introduce market mechanisms into the electricity industry so as to:

- increase economic efficiency through competition;
- attract private investment;
- send accurate price signals to guide production and consumption decisions;
- encourage innovation; and
- provide consumer choice.

### Market Reform Milestones

#### Corporatisation

**1995** Electricity functions of the Public Utilities Board corporatised  
Singapore Power formed as a holding company

**1996** Singapore Electricity Pool (SEP) design process began

#### Singapore Electricity Pool (SEP)

**1998** SEP commenced  
PowerGrid is SEP Administrator and Power System Operator (PSO)

#### National Electricity Market of Singapore (NEMS)

**2000** Decision for further reform to obtain full benefits of competition  
New market design process began

**2001** Electricity industry legislation enacted  
Energy Market Authority (EMA) established as industry regulator and PSO  
Energy Market Company (EMC) established as the NEMS wholesale market operator  
First phase of retail contestability (retail contestability threshold gradually lowered in subsequent years)

**2003** NEMS wholesale market trading began

**2004** Vesting contract regime introduced  
Interruptible loads (IL) began to participate in the reserves market

**2006** First wholesale market trader joined the market and commenced trading as IL provider  
First commercial generator since 2003 joined the market and started trading

**2008** Sale of Tuas Power to China Huaneng Group in March, Senoko Power to Lion Consortium in September, and PowerSeraya to YTL Power in December  
Embedded generators (EG) joined the market

**2009** New EGs, small generators and incineration plants joined and started trading

**2010** Vesting tender introduced to tender out a percentage of non-contestable electricity demand to generation companies for bidding

**2013** Singapore’s Liquefied Natural Gas (LNG) terminal started commercial operations  
LNG vesting contract introduced

**2015** Electricity futures trading commenced

**2016** Demand Response programme introduced

**2018** Open Electricity Market (OEM) launched and rolled out in stages

**2019** Rollout of OEM across Singapore completed  
Vesting contract regime rolled back to LNG vesting contract level

**2021** First energy storage system (ESS) joined the market

**2022** Electricity imports trial commenced

**2023** NEMS completed 20 successful years of trading

## MARKET OVERVIEW: INDUSTRY STRUCTURE

### Participants and Service Providers in the NEMS

Generators			
ExxonMobil Asia Pacific	PacificLight Power	Senoko Waste-to-Energy	Tuas Power Generation
Keppel Merlimau Cogen	Sembcorp Cogen	Shell Singapore*	TuasOne
Keppel Seghers Tuas Waste-to-Energy Plant (Tuas DBOO Trust)	Sembcorp Floating Solar Singapore	Singapore Refining Company	YTL PowerSeraya
National Environment Agency	Sembcorp Solar Singapore	Taser Power	
	Senoko Energy	TP Utilities	
Wholesale Market Traders			
Air Liquide Singapore	HSBC Institutional Trust Services (Singapore)*	Public Utilities Board	Sunseap Leasing
BEWGI-UE NEWater*	JE Green Solutions	Singapore District Cooling	Sunseap Leasing Beta
CrystalClear Environmental	LYS Genco Beta	Singapore LNG Corporation	Sunseap VPower
Enel X Singapore*	MSD International (Singapore Branch)*	SolarLand Alpha Assets	Terrenus Energy SL1X
Green Power Asia	PSA Corporation	Sunseap Energy Ventures*	Terrenus Energy SL2
Retailers			
Best Electricity Supply*	Engie South East Asia*	Keppel Electric	Seraya Energy
Bioenergy	Flo Energy Singapore	PacificLight Energy	Sunseap Energy
Cleantech Solar Singapore Assets	GreenCity Energy*	Sembcorp Power	Tuas Power Supply
Diamond Electric	Just Electric	Senoko Energy Supply	Union Power
Market Support Services Licensee	Market Operator	Power System Operator	Transmission Licensee
SP Services	Energy Market Company	Power System Operator	SP PowerAssets

\* The following market participant changes took place in 2023:

- BEWGI-UE NEWater, HSBC Institutional Trust Services (Singapore) and Engie South East Asia joined the market in March, May and September respectively.
- Enel X Singapore, Sunseap Energy Ventures, Best Electricity Supply, GreenCity Energy and MSD International (Singapore Branch) withdrew from the market in May, June, June, June and December respectively.
- Shell Eastern Petroleum was renamed Shell Singapore.

## MARKET OVERVIEW: INDUSTRY STRUCTURE

Singapore's electricity industry is structured to facilitate competition in its wholesale and retail markets. This competitiveness is achieved by separating the ownership of the contestable parts of the industry from those with natural monopoly characteristics.

### Market Participant Changes

In 2023, the NEMS welcomed two new wholesale market traders (BEWGI-UE NEWater and HSBC Institutional Trust Services (Singapore)) and one new retailer (Engie South East Asia). This brought the total number of market participants (MPs) in the NEMS to 48 at the end of 2023, comprising 17 generators, 17 wholesale market traders and 14 retailers.

### Generation Licensees

Generation licensees are companies with generating facilities of 10 megawatts (MW) or more that are connected to the transmission system and licensed by the Energy Market Authority (EMA) to trade in the wholesale electricity market.

### Wholesale Market Traders

Wholesale market traders are companies, other than generation licensees or retail licensees, that are licensed by the EMA to trade in the wholesale electricity market. Wholesale market traders include companies with generating facilities of less than 10MW, companies that offer their own loads to be interrupted, as well as companies that provide services to other consumers interested in offering their loads to be interrupted.

### Retail Electricity Licensees

Retail electricity licensees are companies that are licensed by the EMA to sell electricity to contestable consumers. Retail electricity licensees that are registered as MPs purchase electricity directly from the wholesale market.

### Market Support Services Licensee — SP Services

A Market Support Services Licensee (MSSL) is authorised to provide market support services. Such services include facilitating customer transfers between retailers, meter reading and meter data management. SP Services is the only MSSL. In addition to its market support services function, SP Services also facilitates access to the NEMS for contestable consumers who have not appointed a retailer, and supplies electricity to non-contestable consumers.

### Market Operator — Energy Market Company

Energy Market Company (EMC) operates and administers the wholesale market. This role includes calculating prices, scheduling generation, clearing and settling market transactions, and procuring ancillary services. EMC also administers the rule change process and provides resources that support market surveillance and compliance, and dispute resolution processes.

### Transmission Licensee — SP PowerAssets

SP PowerAssets owns and is responsible for maintaining the transmission system.

### Power System Operator

The Power System Operator (PSO), a division of the EMA, is responsible for ensuring the reliable supply of electricity to consumers. The PSO controls the dispatch of generation facilities, co-ordinates scheduled outages, oversees power system emergency planning, and directs the operation of the high-voltage transmission network of 66kV and above. The PSO also oversees the real-time operation of the natural gas transmission system.

### Regulator — Energy Market Authority

EMA is the regulator of the electricity and gas industries and has the ultimate responsibility for the market framework and for ensuring that the interests of consumers are protected.

### Consumers

Consumers are classified as either contestable or non-contestable. Contestable consumers purchase electricity from a retailer or from the wholesale market. Non-contestable consumers purchase electricity from SP Services at the regulated tariff.

## MARKET OVERVIEW: MARKET FEATURES

The NEMS has some features that drive efficiency and make its design truly world-class. These include:

- co-optimisation of energy, reserve and regulation products;
- security-constrained dispatch and nodal pricing;
- near real-time dispatch; and
- a Demand Response (DR) programme.

### Co-optimisation of Energy, Reserve and Regulation Products

A sophisticated process involving about 50,000 different mathematical equations is used to determine the price and quantity of the energy, reserve and regulation products traded. Integral to this process is the concept of co-optimisation, wherein the market clearing engine (MCE) considers the overall costs and requirements of all products, then selects the optimal mix of generation and load registered facilities to supply the market.

### Security-Constrained Dispatch and Nodal Pricing

To determine the prices for products traded on the wholesale market, offers made by generators and interruptible loads (ILs) are matched with the system demand forecast and system security requirements. The MCE produces a security-constrained economic dispatch by taking into account the:

- available generation capacity;
- ability of generation capacity to respond (ramping);
- relationship between the provision of energy, reserves and regulation (co-optimisation);
- power flows in the system;
- physical limitations on the flows that can occur in the transmission system;
- losses that are incurred as power is transported; and
- constraints in relation to system security.

This process is run half-hourly to determine the:

- dispatch quantity that each generation unit is to produce and each load facility in the DR programme is to curtail (see details of DR programme on [page 9](#));
- reserve and regulation capacity that each generation unit is required to maintain;
- level of IL that is scheduled; and
- corresponding prices for energy, reserves and regulation in the wholesale market.

### Energy, Reserve and Regulation Products

	Description	Purchaser	Seller
<b>Energy</b>	Generated electricity	Retailers	Generators
<b>Reserve</b>	Stand-by generation capacity or interruptible loads (ILs) that can be drawn upon when there is an unforeseen shortage of supply	Generators	Generators, Retailers and Wholesale Market Traders
	Two classes of reserves are traded: 1) primary reserve (9-second response); and 2) contingency reserve (10-minute response)		
<b>Regulation</b>	Generation that is available to fine-tune the match between generation and load	Generators and Retailers	Generators

Energy prices – referred to as nodal prices – vary at different points on the network. The differences in nodal prices reflect both transmission losses and the physical constraints of the transmission system. This means that the true costs to the market of delivering electricity to each point on the electricity network are revealed.

The MCE models the transmission network and uses linear and mixed integer programming to establish demand and supply conditions at multiple locations (nodes) on the network. Modelling ensures that market transactions are structured in a physically feasible manner, given the capacity and security requirements of the transmission system. For each half-hour trading period, the MCE calculates the prices to be received by generators at the 119 injection nodes, and the prices at up to 890 withdrawal or off-take nodes<sup>1</sup> that are used as the basis for the price to be paid by customers. This method of price determination encourages economically-efficient scheduling of generation facilities in the short term and provides incentives to guide new investment into the power system infrastructure in the long term.

<sup>1</sup> Numbers of injection and withdrawal nodes are as at 31 December 2023.

## MARKET OVERVIEW: MARKET FEATURES

EMC uses metered demand and generation from the MSSL and market prices to settle market transactions on a daily basis. Generators receive the market price for energy that is determined at their point of connection to the transmission network (injection node). Retailers pay the Uniform Singapore Energy Price (USEP) for energy, which is the weighted-average of the nodal prices at all off-take nodes.

Generators pay for reserves according to how much risk they contribute to the system. Regulation is paid for by retailers in proportion to their energy purchases and by dispatched generators up to a ceiling of five megawatt hours for each trading period.

### Near Real-Time Dispatch

Market prices and dispatch quantities for energy, reserves and regulation are calculated five minutes before the start of each half-hour trading period. This ensures that the market outcomes reflect prevailing power system conditions, the most recent offers made by generators, as well as the most recent bids made by demand response aggregators and/or retailers. The result of near real-time calculation of dispatched generation quantities ensures as little real-time intervention as possible and hence minimal deviation from a competitive market solution.

To support near real-time dispatch, EMC produces market forecast schedules up to a week ahead of the relevant trading period. These forecast schedules increase in frequency as the trading period approaches to ensure that MPs have the information they need to adjust their trading positions prior to physical dispatch.

### Demand Response Programme

In April 2016, a new milestone was reached in the NEMS. A DR programme was introduced to allow consumers to submit bids in the energy market for the purpose of providing load curtailments. Loads located in the same zone can be aggregated and registered as a single load registered facility (LRF) in the market. These LRFs can submit energy bids if they satisfy the necessary requirements, and the MCE will schedule them for load curtailment in a given dispatch period. Scheduled and compliant load curtailments will receive incentive payments, which are derived from estimated falls in the USEP and non-regulatory loads. These incentive payments will be recovered from contestable consumers through the hourly energy uplift charges.

An ex-post assessment, comparing actual metering data with the expected consumption based on the LRFs' dispatch schedules, will be conducted. LRFs that are scheduled for curtailment have to reduce their consumption accordingly, while LRFs that are not scheduled for curtailment have to consume at their non-curtailed level. Financial penalties will be imposed on LRFs that are deemed to have deviated from their dispatch schedules, and all financial penalties collected will be returned to the market via the monthly energy uplift charges.

The background features a stylized, futuristic cityscape with tall, angular buildings. The scene is dominated by a dense network of glowing light trails in shades of blue and orange, suggesting data flow or digital connectivity. The perspective is from a low angle, looking up at the structures, which are partially obscured by the light trails. The overall atmosphere is high-tech and dynamic.

# MARKET GOVERNANCE

## MARKET GOVERNANCE: OVERVIEW

### Governing Documents and Institutions

The Energy Market Authority (EMA) was established under the Energy Market Authority of Singapore Act 2001. It is the electricity market regulator under the Electricity Act 2001 and is responsible for, among other mandates:

- creating the market framework for electricity and gas supply;
- promoting the development of the electricity and gas industries;
- protecting the interests of consumers and the public;
- issuing licences; and
- advising the Government on energy policies.

### Rule Change Process

The Energy Market Company (EMC) was established in 2001 and along with it, a new legal and regulatory framework forming the basis for a new electricity market was introduced. The day-to-day functioning of the NEMS wholesale market is governed by the [Singapore Electricity Market Rules](#).

The rule change process is the responsibility of the Rules Change Panel (RCP). Appointed by the EMC Board, RCP members represent generators, retailers, wholesale market traders, the financial community, the Power System Operator (PSO), the Market Support Services Licensee (MSSL), the transmission licensee, electricity consumers and EMC, ensuring representation by all the key sectors of the industry.

The rule change process is designed to maximise transparency and opportunities for public involvement. Rule modifications recommended by the RCP require the support of the EMC Board and the EMA. When approving changes to the Market Rules, the EMA is required to consider whether the proposed rule modifications (i) unjustly discriminate in favour of, or against, a market participant (MP) or a class of MPs; or (ii) are inconsistent with the functions and duties of the EMA under subsection 3(3) of the Electricity Act.

The RCP is supported by EMC's Market Administration team, which provides economic analysis of rule modification proposals and makes recommendations to the RCP. Every year, EMC publishes the RCP's work plan on its [website](#) to ensure that stakeholders remain informed about the likely evolution of the market.

### Market Surveillance and Compliance

The Market Surveillance and Compliance Panel (MSCP) monitors and investigates the conduct of market entities, as well as the structure and performance of, and the activities in, the NEMS. Appointed by the EMC Board, the MSCP comprises professionals independent of the NEMS, whose extensive combined experience spans the areas of financial markets, law, power system operations and economics.

The MSCP is supported by EMC's Market Assessment Unit (MAU). The MAU evaluates activities which indicate breaches of or inefficiencies in the Market Rules, market manuals or System Operation Manual, and potential flaws in the NEMS' overall structure, presenting its findings and recommendations for the MSCP's determination.

Where the MSCP determines that a market entity is not compliant with the Market Rules, the MSCP may take enforcement actions such as imposing financial penalties and issuing non-compliance letters, directions and orders.

The MAU routinely submits the [MSCP Market Watch](#) – a comprehensive quarterly report encompassing monitoring, cataloguing and evaluation activities and analyses – to the MSCP. The MSCP provides a summary of investigative and monitoring activities to EMC in the [MSCP Annual Report](#), which has been published since 2007.

### Dispute Resolution

The Market Rules set out the dispute resolution process for market entities in the NEMS, which consists of three progressive stages: negotiation, mediation, and arbitration. The process is designed to be a fair, efficient and cost-effective way of resolving disputes outside of the courts while maintaining relationships in the NEMS.

The dispute resolution process is managed by the Dispute Resolution Counsellor (DRC) who is appointed by the EMC Board. In addition, the DRC helps familiarise market entities with the dispute resolution and compensation regime, and appoints law professionals to serve on the mediation and arbitration panels, collectively known as the Dispute Resolution and Compensation Panel. The DRC is assisted by the MAU in facilitating dispute resolution in the NEMS, emphasising efficiency and fairness in the dispute resolution and compensation process.

## MARKET GOVERNANCE: LETTER FROM THE CHAIR, RULES CHANGE PANEL

### Dear Industry Members

2023 marks the 20<sup>th</sup> anniversary of the National Electricity Market of Singapore. In two decades, Singapore's electricity industry has evolved from a market dominated by local gas-fired generation plants, to a sophisticated one. It now embraces full retail contestability and has a diversified range of energy sources including electricity import, solar energy and flexible demand. The Rules Change Panel (RCP) has played a crucial role in guiding the market on this evolutionary path.

The exit of several independent retailers following the global energy crunch in 2021 highlighted how important it is for retailers to be able to weather sustained market volatility. To ensure the continued stability of the wholesale market, it is crucial to strengthen the robustness of the prudential regime – key to preserving the financial integrity of the market.

With that in mind, the Panel studied and endorsed EMC's proposed framework for a holistic review of the prudential requirements of the Singapore Wholesale Electricity Market (SWEM), and supported EMC's recommendations for a mechanism to manage insolvency-related events of default.

In these workstreams, I am heartened to see how stakeholders, including the EMA, SP Group and the MSCP, have worked closely with EMC to collectively find solutions to very complex yet critical issues.

With continued support from industry players and stakeholders, I look forward to the development of further proposals on this topic. I am confident that the subsequent proposals, once implemented, would greatly enhance the financial robustness of the SWEM and raise investor confidence.

The Panel has also strived tirelessly to improve information transparency. I firmly believe transparency plays an absolutely essential role in enabling fair competition in the wholesale electricity market. This year, the Panel studied a proposal to improve the quality of published reserve and regulation offers. The proposal sought to introduce filters that would allow published offers to reflect a provider's availability more accurately.

While the Panel acknowledged the importance of accurate representation of offered reserve and regulation, it also understood that intricacies in the physical constraints of different reserve and regulation providers make it impossible to design a set of filters that would accurately account for such effects. Nevertheless, it recognised that EMC's thorough study provided useful insight into the factors that affect the accuracy of offers currently published, helping market participants to better interpret the offers.

In February 2023, the largest battery energy storage system (BESS) in Southeast Asia began operations on Jurong Island. A BESS can bring multiple benefits to system stability by enabling the integration of distributed energy and regulating system frequency.

To provide clarity to the industry on how a BESS operates in the market, the RCP studied a proposal to allow the market clearing engine to effectively incorporate a BESS in the price discovery and dispatch process. The Panel debated intensely over the choice between finely modeling the sophisticated characteristics of BESS and simply relying on the self-commitment of BESS operators that make them responsible for BESS' compliance with dispatch.

I appreciate the candid views shared and the constructive discussions members had at our Panel meetings on this subject. Because of everyone's effort, I am optimistic an optimal solution, that will balance both the needs of the power system and BESS operators, is just around the corner.

The conclusion of 2023 also marked the end of another RCP term. I want to express deep gratitude to the outgoing Panel members, Tony Tan, Song Jian En, Tan Chian Khong and Rachel Su, for three years of dedicated contribution. At the same time, I welcome Kevin Fong, Dallon Kay, Andrew Tan, Wong Yew Chung and Koay Yi Jing to the new Panel in 2024.

I look forward to new perspectives that these members will bring to the table and am confident the new Panel will ably carry the torch and play an influential role in helping the industry to navigate Singapore's energy transition.



**Toh Seong Wah**  
Chair  
Rules Change Panel

## MARKET GOVERNANCE: MARKET EVOLUTION

### Rule Changes Considered by the RCP

As part of the Rule Change Panel's (RCP) continual effort to facilitate development of the wholesale electricity market, the following proposals were considered by the RCP.

#### Publication of Filtered Reserve and Regulation Offer Curves

Since 2019, EMC has made available reserve and regulation offer curves to the industry. In 2020, market participants proposed for EMC to publish "filtered" reserve and regulation offer curves that are adjusted for unit status. The intent was for offers from units that are on outage, running below Minimum Stable Load, or desynchronised from the grid to be excluded in the published curves.

EMC analysed the merit of this proposal based on the two use cases below:

#### a. Use Case 1: To monitor changes in offer behaviour over time

If published offer curves are to be used for monitoring changes in generation companies' offer behaviour over time, EMC assessed that no filtering of offer curves is needed – the current unfiltered offer curves are sufficient for such monitoring purposes. Moreover, switching from unfiltered to filtered offer curves could introduce inconsistencies when attempting to compare offer behaviour before and after filters have been applied.

#### b. Use Case 2: To infer dispatch outcomes

If published offer curves are to be used to infer dispatch outcomes (i.e., dispatch quantities by offer block, market clearing price), applying filters to reflect certain market clearing engine constraints is possible. However, any improvement to the ability to infer dispatch outcomes from them would likely be limited because:

- the number of constraints that can be used as filters are limited, limiting effectiveness; and
- the majority of discrepancies are likely attributable to co-optimisation effects, for which filtering is just not possible.

Given these limitations, the proposal lacked clear benefits. EMC thus recommended not to introduce filtering for reserve and regulation offer curves.

The RCP unanimously supported EMC's recommendation.

### Holistic Review of the Market Rules Related to Cessation of Business, Liquidation, and Insolvency

Currently, when an MP incurs an insolvency-related default, the suspension process as prescribed under existing market rules may not be workable due to potential inconsistency with prevailing laws.

In particular, the MSCP conducting a hearing and issuing a suspension order may not be consistent with the Insolvency, Restructuring, and Dissolution Act and the Companies Act, which may prohibit proceedings against insolvent parties. As a result, the MSCP would not be able to proceed to suspend a defaulting MP.

If the defaulting MP cannot be suspended in a timely manner and continues to trade in the wholesale market without sufficient credit support to cover its exposure, this could negatively impact the financial integrity of the market.

To mitigate the financial risks posed by such an MP, EMC recommended for the market rules to be amended to provide an automatic suspension process for insolvency-related default cases.

The RCP unanimously supported EMC's recommendation.

## MARKET GOVERNANCE: LETTER FROM THE DISPUTE RESOLUTION COUNSELLOR

### Dear Industry Members

#### Dispute Resolution and Compensation Panel

The Dispute Resolution and Compensation Panel (DRCP) was established under the Market Rules to provide dedicated dispute resolution services to the participants of the National Electricity Markets of Singapore (NEMS) when required.

The DRCP members are:

#### Mediation Panel

1. Chandra Mohan
2. Daniel John
3. Engelin Teh, Senior Counsel
4. Geoff Sharp
5. Associate Professor Joel Lee
6. Lim Lei Theng
7. Lim Tat
8. Professor Nadja Alexander
9. Dr Peter Adler
10. Robert Yu
11. Shirli Kirschner

#### Arbitration Panel

1. Chelva Rajah, Senior Counsel
2. Giam Chin Toon, Senior Counsel
3. Gregory Thorpe
4. Kenneth Tan, Senior Counsel
5. Professor Lawrence Boo
6. N Sreenivasan, Senior Counsel
7. Naresh Mahtani
8. Philip Harris
9. Raymond Chan
10. Dr Robert Gaitskell, King's Counsel
11. Tan Chee Meng, Senior Counsel
12. Professor Tan Cheng Han, Senior Counsel

#### Dispute Management System Contacts

Pursuant to the Market Rules, each market entity has nominated at least one Dispute Management System (DMS) contact to be the first point of engagement in the event of a dispute.

The current DMS contacts are:

1. Air Liquide Singapore – Lim Yong Yi
2. Bioenergy – David Leong
3. Cleantech Solar Singapore Assets – Andre Nobre
4. Diamond Electric – Dallon Kay
5. Energy Market Company – Dominic Tan
6. Engie South East Asia – Floriane Jacquart
7. Engie South East Asia – Sharlin Khor
8. ExxonMobil Asia Pacific – Lim Li Fang
9. ExxonMobil Asia Pacific – Ma Xiu Yan
10. Flo Energy Singapore – Matthijs Guichelaar
11. Green Power Asia – Daniel Ma
12. JE Green Solutions – Chin Cherk Min
13. JE Green Solutions – Tan Kuen Jong
14. Just Electric – Wittman Wah
15. Keppel Electric – Joelyn Wong
16. Keppel Electric – Tay Hock Hai
17. Keppel Merlimau Cogen – Jeremy Lim
18. Keppel Merlimau Cogen – Sean Chan
19. LYS Genco Beta – Jonathan Chong
20. National Environment Agency – Sara Raeburn

## MARKET GOVERNANCE: LETTER FROM THE DISPUTE RESOLUTION COUNSELLOR

- |   |   |
|---|---|
| 21. National Environment Agency<br>- Yap Hwee Tat         | 46. Singapore Refining Company<br>- Balasubramaniam Sundararaj<br>Mohanakkannan |
| 22. PacificLight Energy - Ng Zi Kang                      | 47. Singapore Refining Company<br>- Ho Weng Foo                                 |
| 23. PacificLight Power - Yang Jia Xin                     | 48. SP PowerAssets - Chan Hung Kwan   |
| 24. Power System Operator - Loh Poh Soon                  | 49. SP Services - Kevin Fong  |
| 25. Power System Operator - Lee Kim Hwee                  | 50. SP Services - Lee Chui Ping   |
| 26. Public Utilities Board - Lee Si Jia                   | 51. SP Services - Rachel Su   |
| 27. Sembcorp Cogen - Lai Kum Fai                          | 52. Taser Power - Albert Siah   |
| 28. Sembcorp Floating Solar Singapore<br>- Fendy Nursalim | 53. Taser Power - Kenrick Tan   |
| 29. Sembcorp Floating Solar Singapore<br>- Kenny Kee      | 54. Terrenus Energy SL1X - Charles Wong   |
| 30. Sembcorp Power - Serina Wong                          | 55. Terrenus Energy SL1X - David Chan   |
| 31. Sembcorp Solar Singapore - Fendy Nursalim             | 56. Terrenus Energy SL2 - Charles Wong  |
| 32. Sembcorp Solar Singapore - Kenny Kee                  | 57. Terrenus Energy SL2 - David Chan  |
| 33. Senoko Energy - Poo Siok Yin                          | 58. TP Utilities - Daniel Lee   |
| 34. Senoko Energy Supply - Michelle Lim                   | 59. Tuas DBOO Trust - Chen Zhixuan  |
| 35. Senoko Waste-to-Energy - Clifton Tan                  | 60. Tuas DBOO Trust - Victor Fong   |
| 36. Senoko Waste-to-Energy - Lee Song Koi                 | 61. Tuas Power Generation - Priscilla Chua                                      |
| 37. Seraya Energy - Alex Liam                             | 62. Tuas Power Supply - Jazz Feng   |
| 38. Seraya Energy - Sarah Sum                             | 63. Tuas Power Supply - Kessler Wong  |
| 39. Shell Singapore - Benny Leng                          | 64. TuasOne - Kwanwei Sim   |
| 40. Shell Singapore- Wee Tien Ai                          | 65. TuasOne - Mitsuru Tada  |
| 41. Shell Singapore - Teo Woon Kai                        | 66. Union Power - Ellen Teo   |
| 42. Singapore District Cooling - Dennis Chong             | 67. Union Power - Eric Lim  |
| 43. Singapore District Cooling - John Tan                 | 68. YTL PowerSeraya - Christina Lye Jia Yu                                      |
| 44. Singapore LNG Corporation - Bian Qi Jun               | 69. YTL PowerSeraya - Lee Si Jie  |
| 45. Singapore LNG Corporation - Ho Jia Hua                |   |

### Dispute Resolution Training

As an integral aspect of the responsibilities under my role, I am entrusted with the provision of training in dispute resolution matters tailored for the stakeholders within the DMS.

On 16 June 2023, I conducted a detailed briefing and refresher session concerning the NEMS' dispute resolution process specifically designed for the DMS contacts. This workshop, inclusive of a networking lunch, was conducted with the support and coordination of Energy Market Company's Market Assessment Unit.

### Conclusion

I am pleased to convey that throughout 2023, no formal disputes were submitted with our office. I extend my gratitude to the esteemed members of the DRCP and the DMS contacts for their invaluable contributions. I anticipate the continuation of this collaborative effort and reaffirm my dedicated commitment to diligently address and support the dispute resolution requirements of all entities within the NEMS in the forthcoming year.



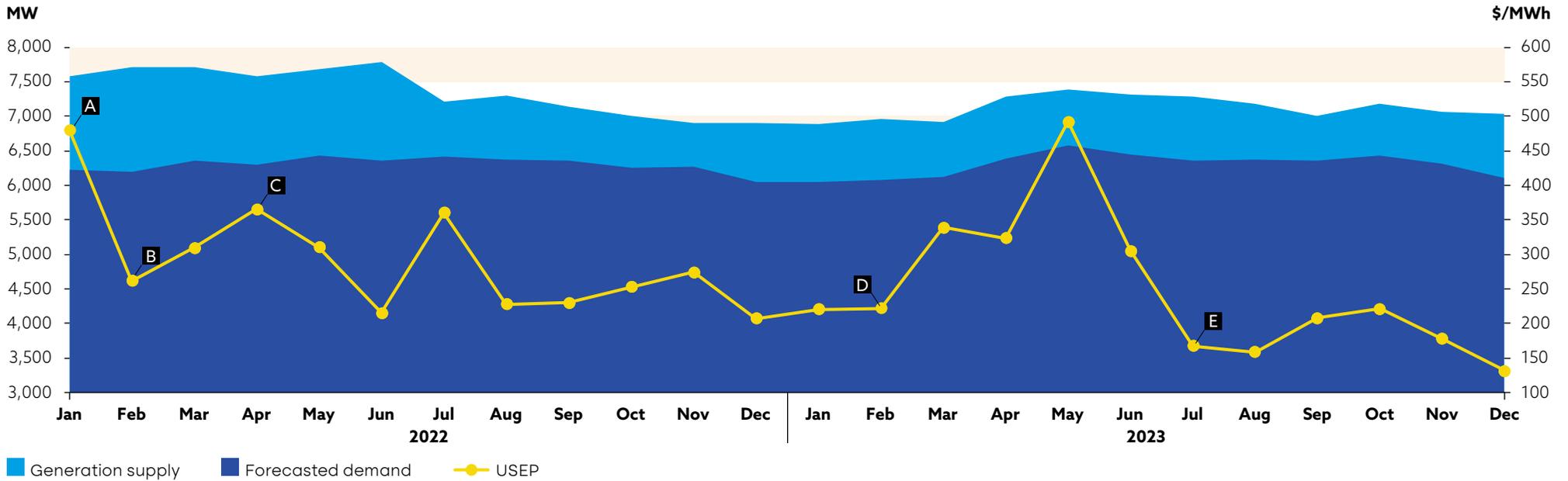
**George Lim**  
**Senior Counsel**  
Dispute Resolution Counsellor

# MARKET PERFORMANCE



# MARKET PERFORMANCE: OVERVIEW OF THE YEAR

## Impact of Post-pandemic Events on Monthly USEP, Forecasted Demand and Generation Supply in 2022-2023



**Key highlights:**  
 A) Measures to stabilise the power system and market  
 B) Geopolitical conflict  
 C) Further easing of Covid-19 restrictions  
 D) Lifting of Covid-19 restrictions  
 E) TPC mechanism and new five-year Vesting Regime Framework

Since Singapore began post-pandemic economic recovery in 2022, several significant events have shaped the National Electricity Market of Singapore (NEMS).

Volatile prices arising from the global energy crunch marked the beginning of 2022. To stabilise the market, the Energy Market Authority (EMA) introduced measures to help the market tide over the energy crunch. The ongoing Russia-Ukraine conflict that emerged at the end of February 2022 strained global supply chains, while electricity demand rose after Covid-19 restrictions were relaxed in April 2022 to allow all employees to return to the workplace.

In February 2023, Covid-19 restrictions were further eased, marking Singapore’s full resumption of economic activities. The market saw price volatility in the second quarter, mainly arising from the post-pandemic surge in electricity demand. Prices began to stabilise following the EMA’s introduction of the Temporary Price Cap (TPC) mechanism on 1 July 2023 and a new five-year Vesting Regime Framework, which also took effect on 1 July 2023 and will stay in force till 30 June 2028.

The TPC mechanism mitigates prolonged extreme price volatility by putting a temporary price cap on wholesale electricity prices, while the new Vesting Regime Framework enables the Market Support Services Licensee (MSSL) to continue offering stable and regulated tariffs to non-contestable consumers.

## MARKET PERFORMANCE: OVERVIEW OF THE YEAR

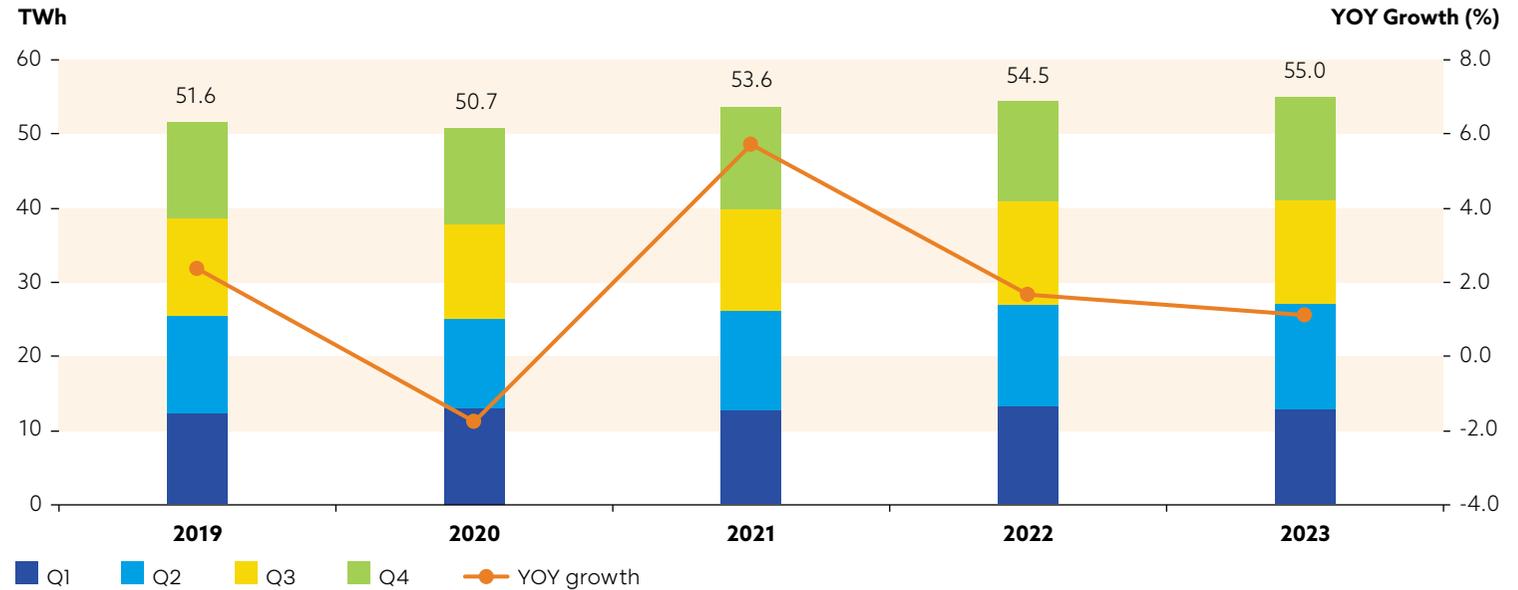
### Electricity consumption continues growth in 2023 albeit at a slower rate

Electricity purchased by market participants (MP) is settled using electricity consumption data provided by the MSSL.

In line with the 1.2 percent<sup>2</sup> growth in Singapore's economy, a slowdown from 2022, the annual growth in electricity consumption also slowed to 0.9 percent year-on-year (YOY). Total electricity consumption stood at 55.0 terawatt hour (TWh), surpassing the peak registered last year.

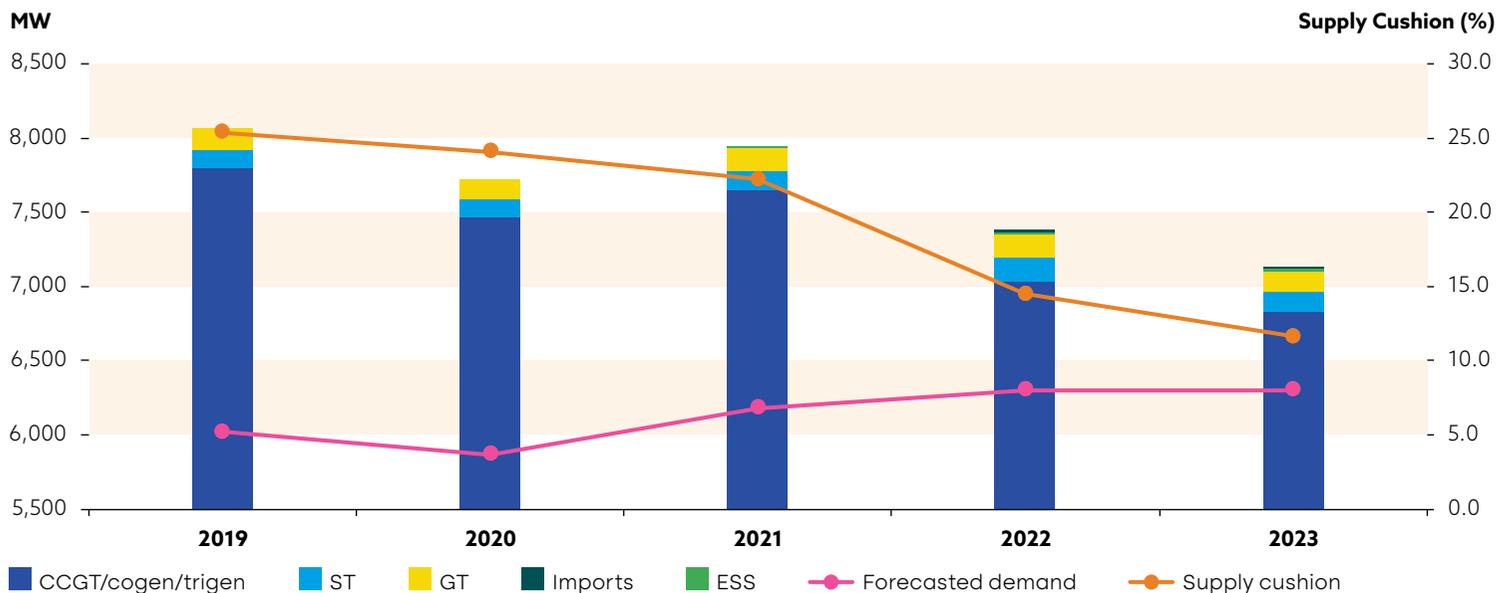
Compared to the same quarters in 2022, electricity consumption contracted 2.3 percent in the first quarter and grew between 1.4 and 3.0 percent YOY in the last three quarters of 2023. Notably, the electricity consumption levels in the second, third and fourth quarters were the highest quarterly levels since the market started. The decline of 2.3 percent in the first quarter correlated with lower temperatures and a contraction in Q1's manufacturing sector activity. The largest increase of 3.0 percent YOY was recorded in the fourth quarter, on the back of economic recovery in most sectors, particularly manufacturing and construction.

### Annual Electricity Consumption 2019-2023



# MARKET PERFORMANCE: OVERVIEW OF THE YEAR

## Annual Generation Supply by Plant Type 2019-2023



### Annual generation supply and supply cushion continue downward trend

The annual generation supply dipped 3.4 percent to 7,127 megawatts (MW)<sup>3</sup>, which was the lowest level since 2013. As a result, the supply cushion<sup>4</sup> contracted 2.9 percentage points to a record low of 11.6 percent in 2023.

In line with the lower overall generation supply, combined-cycle gas turbine/cogeneration/trigeneration (CCGT/cogen/trigen) supply fell 2.8 percent to 6,835MW, the lowest level since 2014. The CCGT/cogen/trigen supply was 8.4 percent above forecasted demand, which was the narrowest margin in the past 12 years.

Steam turbine (ST) and gas turbine (GT) supply contracted 24.3 and 6.7 percent to 128MW and 139MW respectively. Energy storage systems (ESS) supply<sup>5</sup> surged more than five-folds to 16MW in 2023, from the 3MW in 2022. Import supply averaged at 9MW in 2023, 12MW lower than 2022.

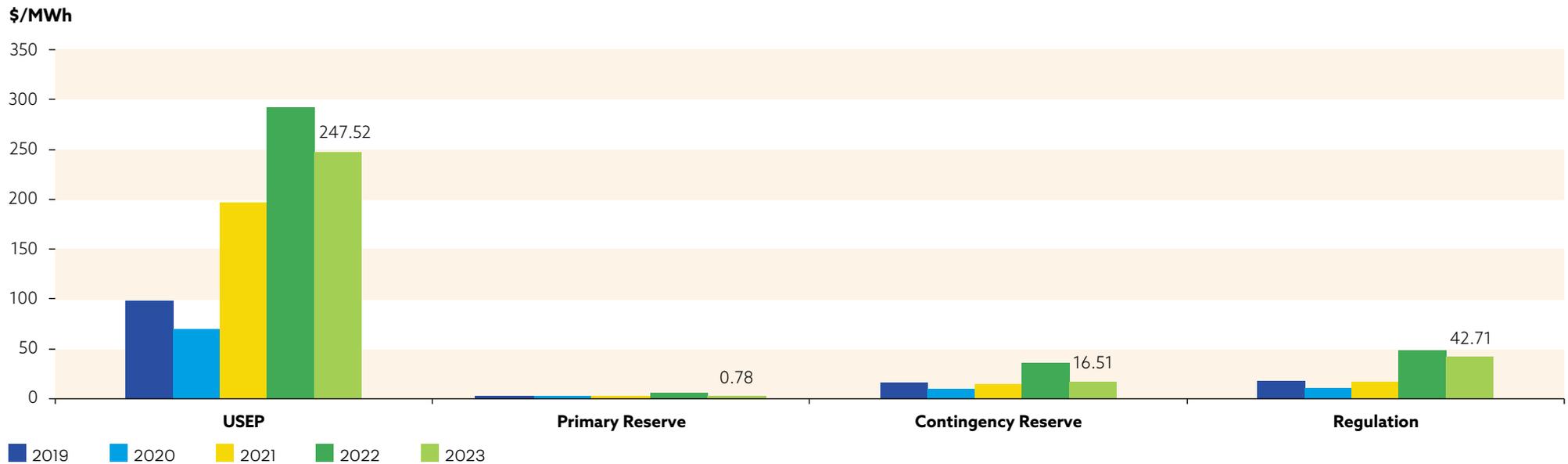
<sup>3</sup> Since 2022, total supply has included energy storage systems supply and imports. The first imports entered the market in June 2022.

<sup>4</sup> Supply cushion measures the percentage of total generation supply that is available and offered into the market after matching off forecasted demand. It is calculated by subtracting forecasted demand from total supply, over total supply.

<sup>5</sup> Based on modelled offer capacity.

## MARKET PERFORMANCE: OVERVIEW OF THE YEAR

### Annual USEP and Ancillary Prices 2019–2023



#### Prices of all products fall in 2023

The annual average Uniform Singapore Energy Price (USEP) fell 15.2 percent to \$247.52 per megawatt hour (MWh) in 2023 from its peak of \$291.81/MWh in 2022. Despite that YOY drop, the average USEP for the year was still the second highest it has been since the market started. The annual average USEP was 28.2 percent above the annual average vesting price<sup>6</sup> of \$193.07/MWh.

The primary reserve price decreased 52.4 percent to \$0.78/MWh in 2023 from \$1.64/MWh in 2022. The decrease came as a result of a net increase in primary reserve offers.

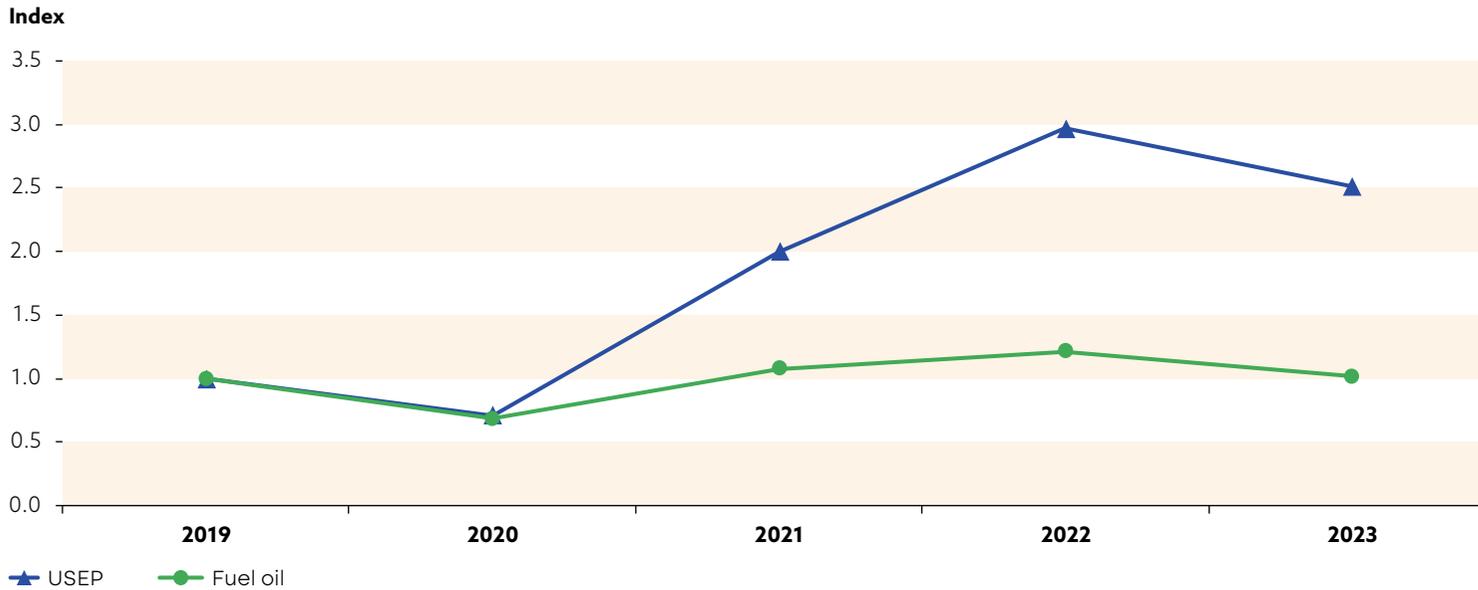
The contingency reserve price decreased 54.3 percent to \$16.51/MWh in 2023 from \$36.11/MWh in 2022 due to lower requirement and fewer number of periods with contingency reserve shortfall as compared to 2022.

The regulation price decreased 11.4 percent to \$42.71/MWh in 2023 from \$48.20/MWh in 2022 due to more offers in the cheaper tranches and a decrease in the number of periods with regulation shortfall. The requirement was also revised downward to 117MW from 120MW, as of 1 February 2023.

<sup>6</sup> The annual vesting price was derived from LNG Vesting Price in Q1 and Q2 2023, and Balance Vesting Price in Q3 and Q4 2023.

# MARKET PERFORMANCE: OVERVIEW OF THE YEAR

## Annual USEP and Fuel Oil Price Movements 2019-2023



### USEP falls in parallel with fuel oil price<sup>7</sup>

The USEP index<sup>8</sup> decreased to 2.52 while the fuel oil price index dropped to 1.02 in 2023. Both indices moved in tandem, with the USEP index leading the decline.

For both indices, the decline in 2023 came after two consecutive years of increase. The decline in the USEP index outpaced that of the fuel oil price index in 2023, slightly narrowing the gap between the two indices.

<sup>7</sup> The fuel oil price index is used here as a proxy for fuel oil prices.

<sup>8</sup> The USEP index is computed using 2019 as the index base. Therefore, the USEP index in 2019 is 1, while the USEP index in 2023 is 2.52 (computed using the 2023 USEP of \$247.52/MWh divided by the 2019 USEP of \$98.28/MWh).

## MARKET PERFORMANCE: OVERVIEW OF THE YEAR

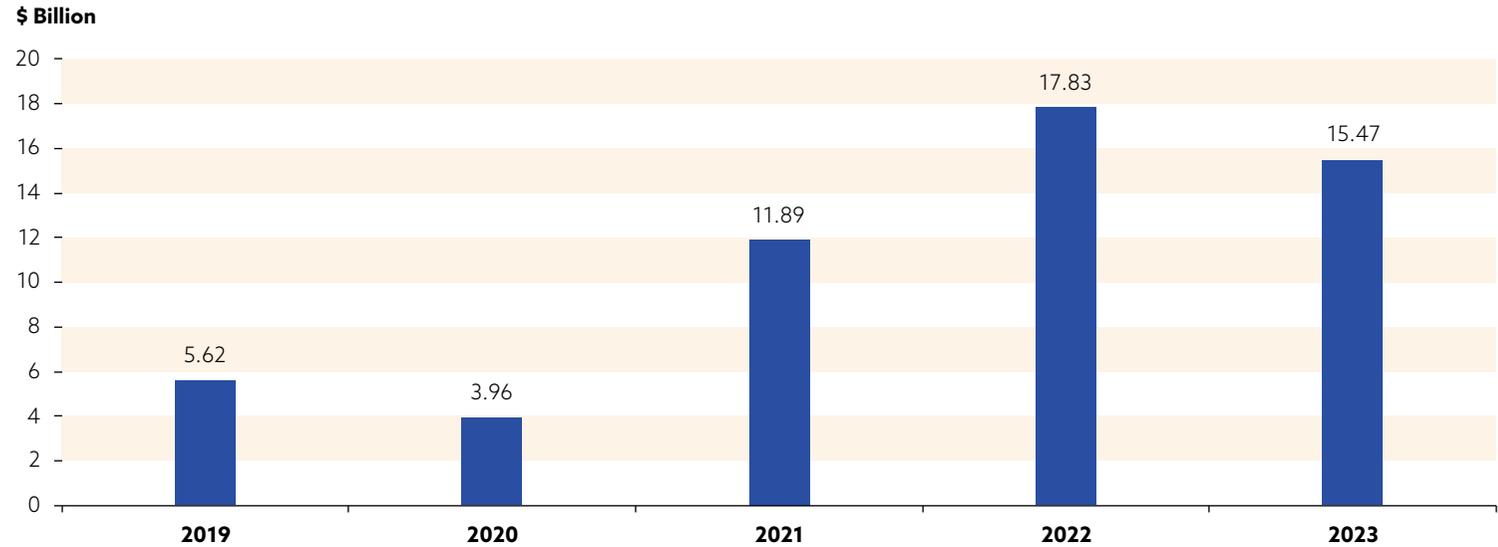
### Annual value of products traded declines after two consecutive years of increase

The value of products traded is the transacted value of all products traded in the NEMS, in the energy, reserves, and regulation markets. Energy Market Company (EMC) uses the metered demand and generation data from the MSSL as well as market prices in the NEMS to settle market transactions daily.

In 2023, the annual value of products traded fell 13.2 percent to \$15.47 billion from its peak in 2022. This drop, which followed two consecutive years of increase, was due to lower market prices. Notably, it was still the second highest annual value of products traded since the market started.

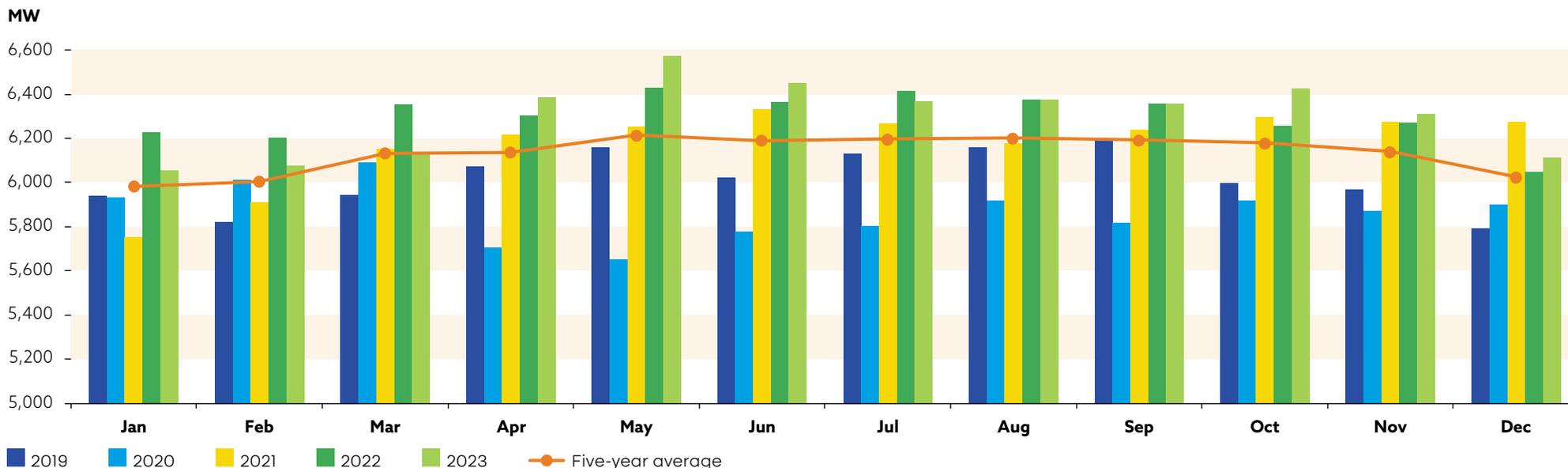
The energy market accounted for 99.3 percent of all products traded, while the reserve and regulation markets accounted for 0.4 percent and 0.3 percent respectively.

### Annual Value of Products Traded 2019-2023



## MARKET PERFORMANCE: ENERGY DEMAND

### Monthly Forecasted Demand 2019-2023



#### Forecasted demand rises in most months

Forecasted demand refers to the projected electricity consumption in Singapore. The forecast is provided in real time by the Power System Operator (PSO) and is a key component in determining the USEP.

The annual forecasted demand was 6,303MW in 2023, a marginal increase of 3MW from 2022. The monthly forecasted demand reached new highs from April to June, and from August to November.

Compared to 2022, demand was stronger from April to June, and August to December. In 2023, monthly average demand was highest in May, which registered the second largest YOY jump of 2.2 percent to 6,574MW. The highest monthly average demand in May was in line with the warmer weather. The average temperature in May 2023 was 29.5 degrees Celsius, the highest monthly average temperature recorded since March 1998<sup>9</sup>. Monthly average demand was lowest in January, which registered the second steepest YOY decline of 2.7 percent to 6,055MW. The steepest YOY decline of 3.5 percent was recorded in March.

Over the last five years, the peak half-hourly demand has shifted to later in the day, underlining the impact of the growing contribution of intermittent generation sources (IGS). In 2023, the peak half-hourly demand climbed to a new high of 7,569MW in Period 33 on 15 May 2023, which was 2.7 percent above 2022's peak of 7,371MW recorded in Period 34 on 31 May 2022.

9 *Historical Extreme Temperatures: Meteorological Service Singapore, Singapore, 31 December 2023.*

## MARKET PERFORMANCE: ENERGY SUPPLY

### Generation and Load Facilities Registered, De-registered and Revised in 2023

#### New Facilities Registered

Month of Registration	Generation Type	Market Participant	Registered Capacity
March	1 ESS unit	<b>Sembcorp Cogen</b>	1.200MW
	1 IGS unit	<b>Terrenus Energy SL1X</b>	9.970MW
	1 NEIGF unit	<b>BEWGI-UE NEWater</b>	1.540MW
April	1 NEIGF unit	<b>LYS Genco Beta</b>	1.400MW
May	1 IGS unit	<b>Sembcorp Solar Singapore</b>	0.150MW
	1 IGS unit	<b>HSBC Institutional Trust Services</b>	0.400MW
June	1 LRF unit	<b>Singapore District Cooling</b>	2.500MW for load curtailment
July	1 LRF unit	<b>Diamond Electric</b>	2.000MW for contingency reserve
September	1 IGS unit	<b>Singapore District Cooling</b>	0.100MW
	1 LRF unit	<b>Singapore District Cooling</b>	2.000MW for load curtailment
December	1 IGS unit	<b>Engie South East Asia</b>	1.870MW

#### Facilities De-registered

Month of De-registration	Generation Type	Market Participant	Registered Capacity
March	1 IGS unit	<b>Terrenus Energy SL1X</b>	4.650MW
May	1 LRF unit	<b>Enel X Singapore</b>	1.900MW
June	1 NEIGF unit	<b>LYS Genco Beta</b>	1.400MW
October	1 ESS unit	<b>Sembcorp Cogen</b>	2.000MW
November	1 LRF unit	<b>Sunseap VPower</b>	0.100MW for contingency reserve
December	2 CCGT/cogen/trigen units	<b>MSD International GmbH (Singapore Branch)</b>	4.800MW each

#### Capacity Revisions

Generation Type	Market Participant	Registered Capacity
1 LRF unit	<b>Diamond Electric</b>	4.000MW for load curtailment
1 IGS unit	<b>HSBC Institutional Trust Services</b>	8.300MW
1 LRF unit	<b>Just Electric</b>	48.000MW for load curtailment
1 CCGT/cogen/trigen unit	<b>Keppel Merlimau Cogen</b>	420.000MW
1 CCGT/cogen/trigen unit	<b>PacificLight Power</b>	415.000MW
1 ESS unit	<b>PSA Corporation</b>	2.200MW
1 ESS unit	<b>Sembcorp Cogen</b>	2.000MW
2 IGS units	<b>Sembcorp Solar Singapore</b>	10.472MW, 1.416MW
2 LRF units	<b>Singapore District Cooling</b>	3.600MW, 2.200MW for load curtailment
1 IGS unit	<b>Singapore District Cooling</b>	3.650MW
1 IGS unit	<b>SolarLand Alpha Assets</b>	22.200MW
1 CCGT/cogen/trigen unit (under ECIS <sup>10</sup> )	<b>SP Services</b>	23.696MW
2 IGS units (under ECIS <sup>10</sup> )	<b>SP Services</b>	578.256MW, 17.557MW
1 IGS unit	<b>Sunseap Leasing Beta</b>	3.206MW

CCGT/cogen/trigen = Combined-cycle gas turbine/cogeneration/trigeneration (combined category) | ESS = Energy storage systems | GT = Gas turbine | IGS = Intermittent generation sources | NEIGF = Non-exporting embedded intermittent generation facilities | ST = Steam turbine

<sup>10</sup> Enhanced Central Intermediary Scheme for Embedded Generation. The capacity revisions of SP Services' facilities effective on 4 Jan 2024 were included to better reflect the actual capacities as at 2023.

## MARKET PERFORMANCE: ENERGY SUPPLY

### 11 new facilities registered in 2023

At the end of 2023, the total registered capacity<sup>11</sup> of generation facilities in the NEMS stood at 13,015MW. Of this, 81.0 percent or 10,546MW belonged to the CCGT/cogen/trigen category. As at 31 December 2023, there were 114 generation facilities, 10 load facilities, one import facility and four ESS facilities registered in the NEMS.

During the year, nine MPs added 11 new facilities to the market: seven IGS<sup>12</sup> facilities, three load facilities, and one ESS facility. In addition, three CCGT/cogen/trigen facilities, eight IGS facilities, four load facilities and two ESS facilities revised their registered capacity in the course of the year.

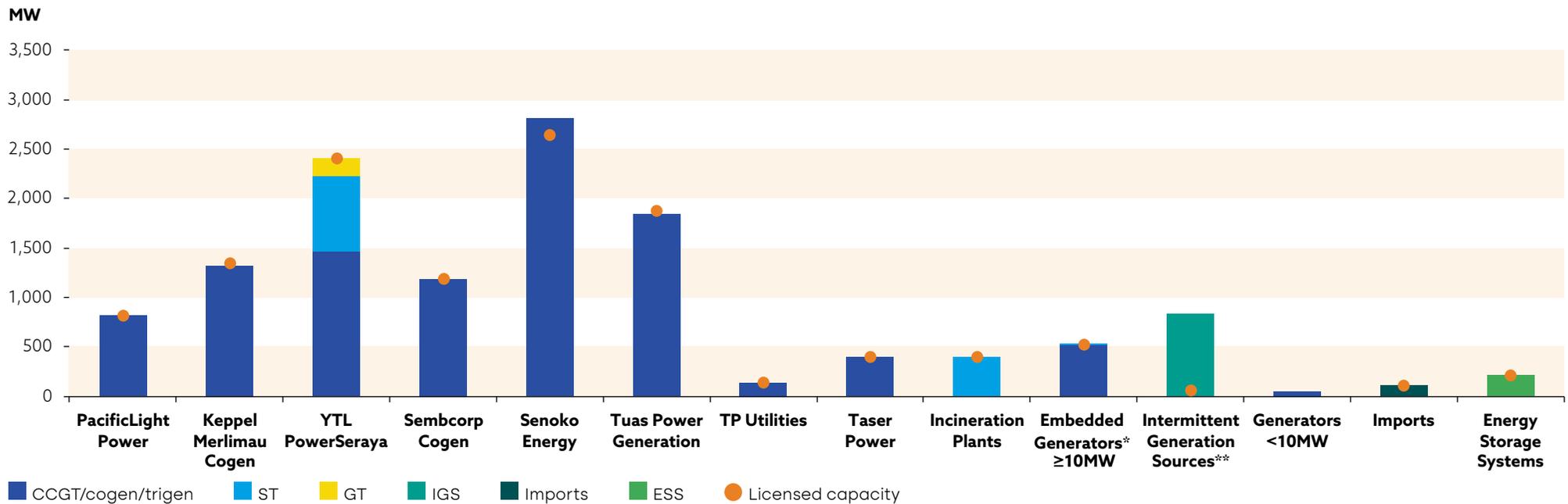
Seven facilities were de-registered in 2023: two CCGT/cogen/trigen facilities from MSD International GmbH (Singapore), two IGS facilities from Terrenus Energy SL1X and LYS Genco Beta, one ESS facility from Sembcorp Cogen, and two load facilities from Enel X Singapore and Sunseap VPower prior to their withdrawal from the market. Additionally, Sunseap Energy Venture's 4.9MW ESS unit was transferred to Singapore District Cooling prior to its withdrawal from the market.

<sup>11</sup> Registered capacity included energy storage systems and imports.

<sup>12</sup> Includes non-exporting embedded intermittent generation facilities (NEIGFs) registered in 2023.

## MARKET PERFORMANCE: ENERGY SUPPLY

### Generation Capacity as at 31 December 2023: Registered Versus Licensed



\* Embedded generators exclude TP Utilities.

\*\* Intermittent generation sources include NEIGFs.

Licensed capacity for facilities <10MW excluded as the information is not publicly available.

### Licensed and registered capacities increase in 2023

Total licensed capacity<sup>13</sup> in the NEMS (which captures facilities with a generation capacity larger than or equal to 10MW) rose 23MW to 12,068MW<sup>14</sup> in 2023. That increase stemmed from a PacificLight Power CCGT/cogen/trigen facility expanding generation capacity by 15MW and an ExxonMobil Asia Pacific embedded generator expanding generation capacity by 8MW.

Total registered capacity<sup>15</sup> of generation facilities increased 3.6 percent to 13,015MW in 2023 from 12,563MW in 2022. This was attributed to three CCGT/cogen/trigen facilities (from PacificLight Power, Keppel Merlimau Cogen and SP Services<sup>16</sup>) revising their capacities upwards, and was also due to the registered capacity of IGS including non-exporting embedded intermittent generation facilities (NEIGF) more than doubled YOY to 825MW.

CCGT/cogen/trigen facilities continued to account for the bulk - 81.0 percent - of total registered capacity in 2023. However, this was 2.8 percentage points smaller than their share in 2022, as other sources' contribution grew. IGS, including NEIGFs, made up a larger 6.3 percent of total registered capacity as the category's share grew 3.1 percentage points from 2022.

ESS' share shrank 0.1 percentage point to 1.6 percent of total registered capacity, while import registered capacity's share remained at 0.8 percent.

<sup>13</sup> Since 2020, the total registered capacity has been greater than the total licensed capacity. This was primarily due to increasing capacities of intermittent generation sources which were mostly excluded from the total licensed capacity.

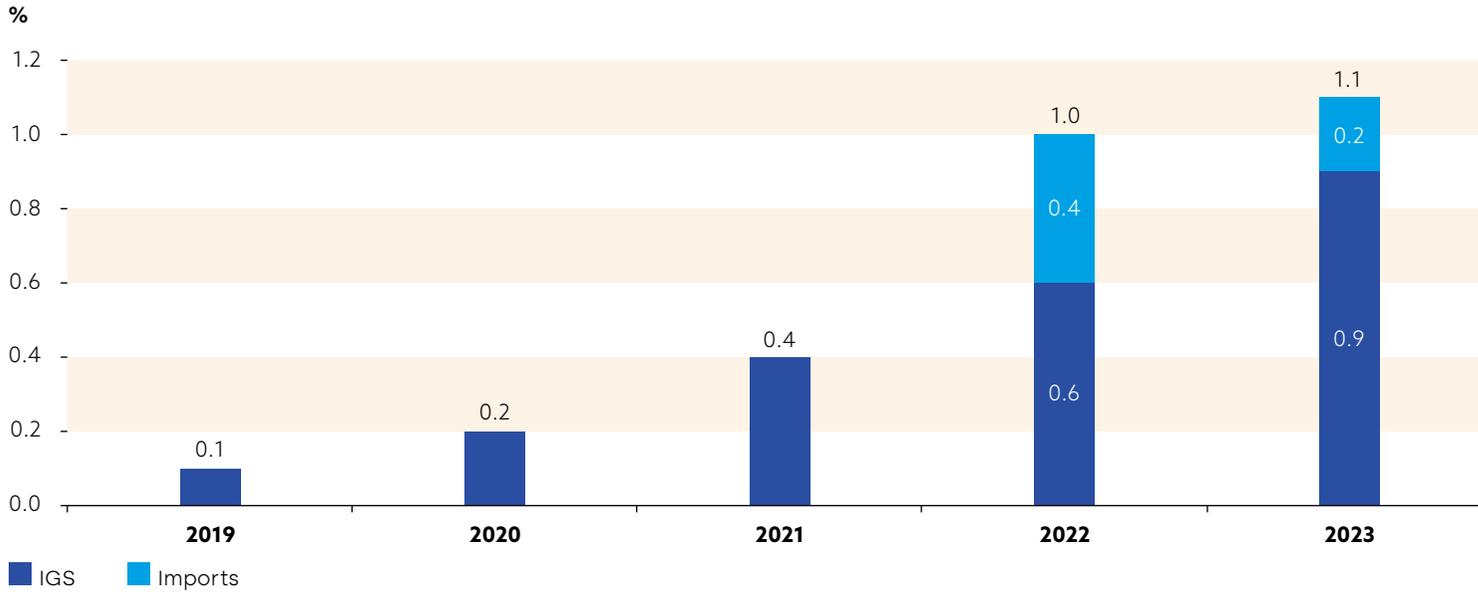
<sup>14</sup> Licensed capacity included generation facilities ≥10MW and an import. The first import entered the market in 2022.

<sup>15</sup> The registered capacity for 2023 includes import facility, ESS facilities and capacity revisions of SP Services facilities effective on 4 Jan 2024 to better reflect the actual capacities as at 2023.

<sup>16</sup> SP Services CCGT/cogen/trigen facility under the Enhanced Central Intermediary Scheme for Embedded Generation.

# MARKET PERFORMANCE: ENERGY SUPPLY

## Renewable Generation Market Share 2019–2023 (Based on Metered Generation)



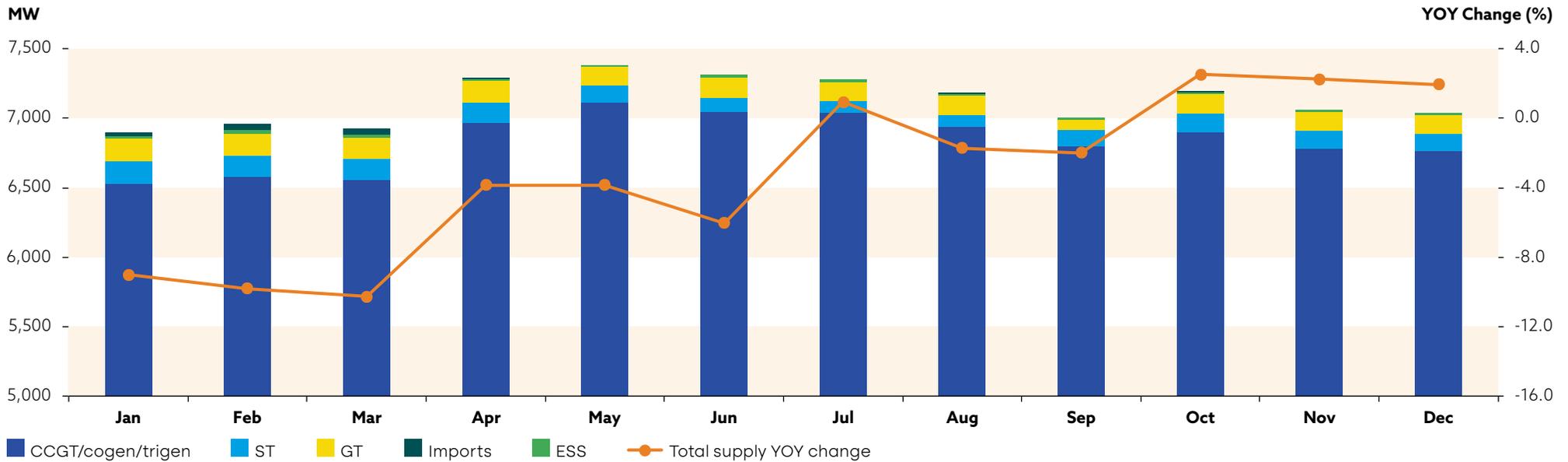
### Renewable generation market share increases at a slower rate

The combined market share of renewable generation (i.e., generation from IGS and import facilities) continued to grow, albeit by a marginal 0.1 percentage point, to 1.1 percent in 2023. This slowed from the 0.6 percentage point growth in renewable generation’s market share in 2022.

Among the renewable generation types, IGS continued to dominate with a market share of 0.9 percent, growing 0.3 percentage point from 2022. Notably, this was the largest increase in IGS’ market share since 2018. The strong growth in IGS was, however, dampened by Imports, which saw a 0.2 percentage point contraction in market share to 0.2 percent.

## MARKET PERFORMANCE: ENERGY SUPPLY

### Monthly Supply by Plant Type 2023



#### Total supply registers YOY decline in most months

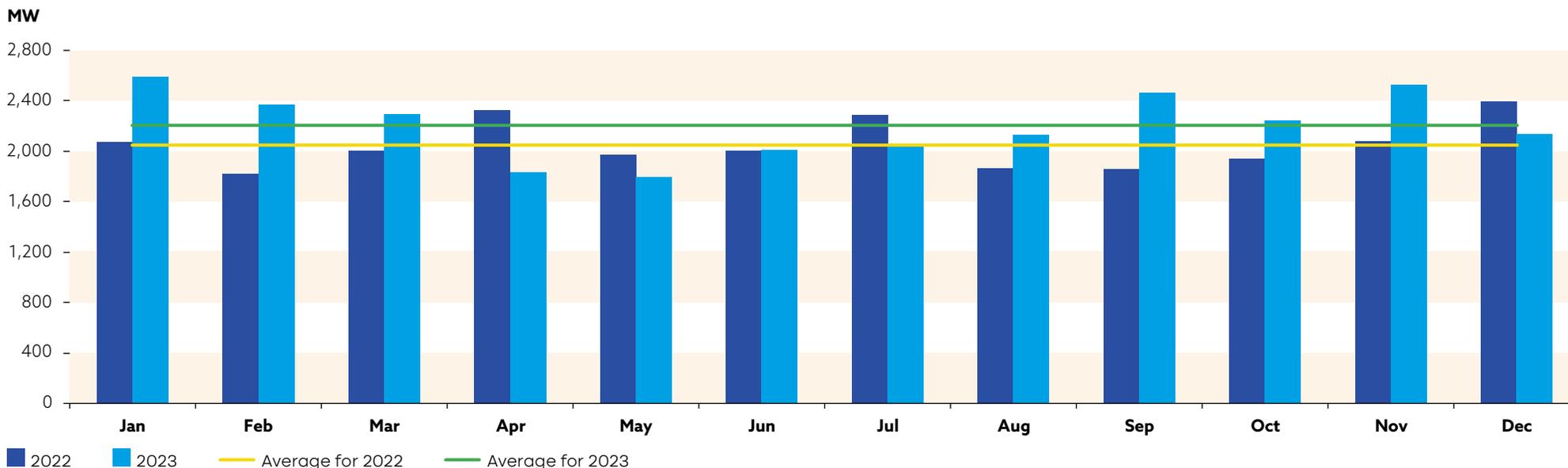
The total supply shrank between 1.7 percent and 10.3 percent in eight out of 12 months in 2023. The largest YOY decline occurred in March while the smallest YOY decline was in August.

The most efficient generation type – CCGT/cogen/trigen – continued to dominate with a 95.9 percent share of the total supply. This was 0.6 percentage point larger than its share in 2022. The proportion of ST supply shrank 0.5 percentage point to 1.8 percent, while that of GT supply remained at 2.0 percent. The proportion of import supply shrank 0.2 percentage point to 0.1 percent, while that of ESS supply grew 0.1 percentage point to 0.2 percent.

In 2023, the monthly supply fell below the 7,500MW level in all months, highlighting the weaker supply compared to the past few years. The monthly supply was highest in May at 7,384MW, and lowest in January at 6,896MW.

# MARKET PERFORMANCE: ENERGY SUPPLY

## Monthly Generation Maintenance 2022 Versus 2023



### Generation maintenance increases in 2023

The annual average generation maintenance level<sup>17</sup> increased 7.5 percent to 2,203MW in 2023. The monthly generation maintenance levels were higher YOY for eight out of 12 months. The highest monthly average generation maintenance level of 2,590MW was in January, while the lowest level of 1,797MW was in May.

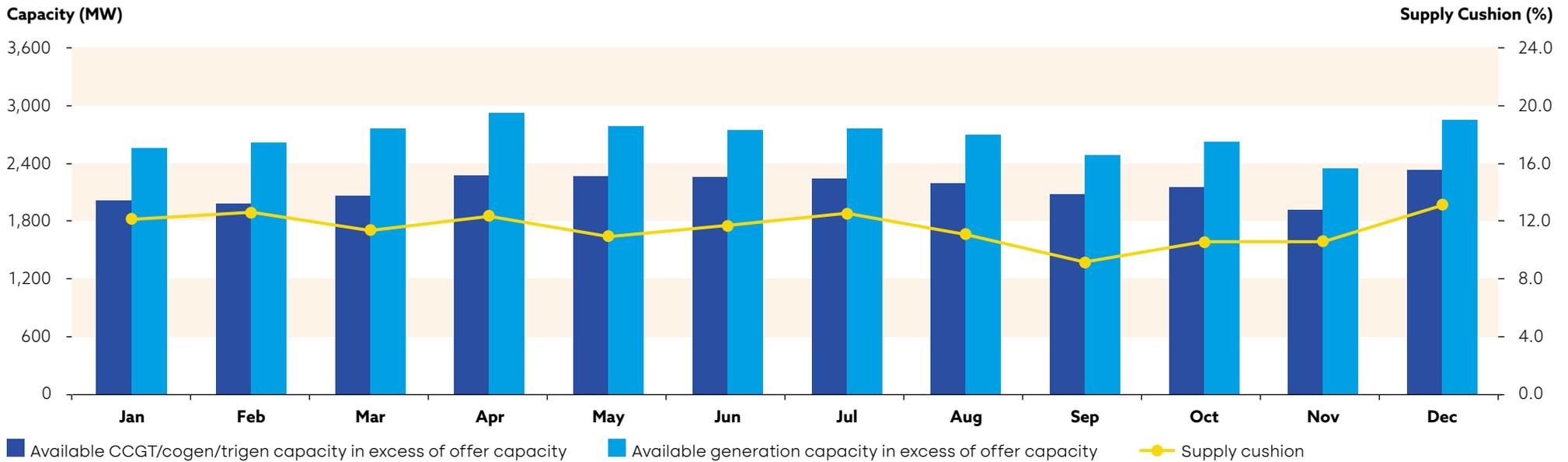
The standard deviation of monthly generation maintenance increased to 258MW in 2023 from 191MW in 2022, as the monthly generation maintenance range widened to between 1,797MW and 2,590MW.

The ratio of generation maintenance to registered capacity<sup>18</sup> increased to 16.9 percent in 2023 from 16.3 percent in 2022.

<sup>17</sup> Generation maintenance refers to the overhaul and retrofiting of generation facilities. Generation maintenance levels are calculated based on the Annual Generator Outage Programme (AGOP) provided by the PSO.  
<sup>18</sup> From 2022, registered capacity included energy storage systems and imports.

## MARKET PERFORMANCE: ENERGY SUPPLY

### Monthly Supply Cushion and Available Generation Capacity in Excess of Offer Capacity 2023



#### More available generation capacity in excess of offer capacity in the first half of the year

The movements in the available CCGT/cogen/trigen capacity in excess of offer capacity were largely in line with those of the available generation capacity in excess of offer capacity throughout the year.

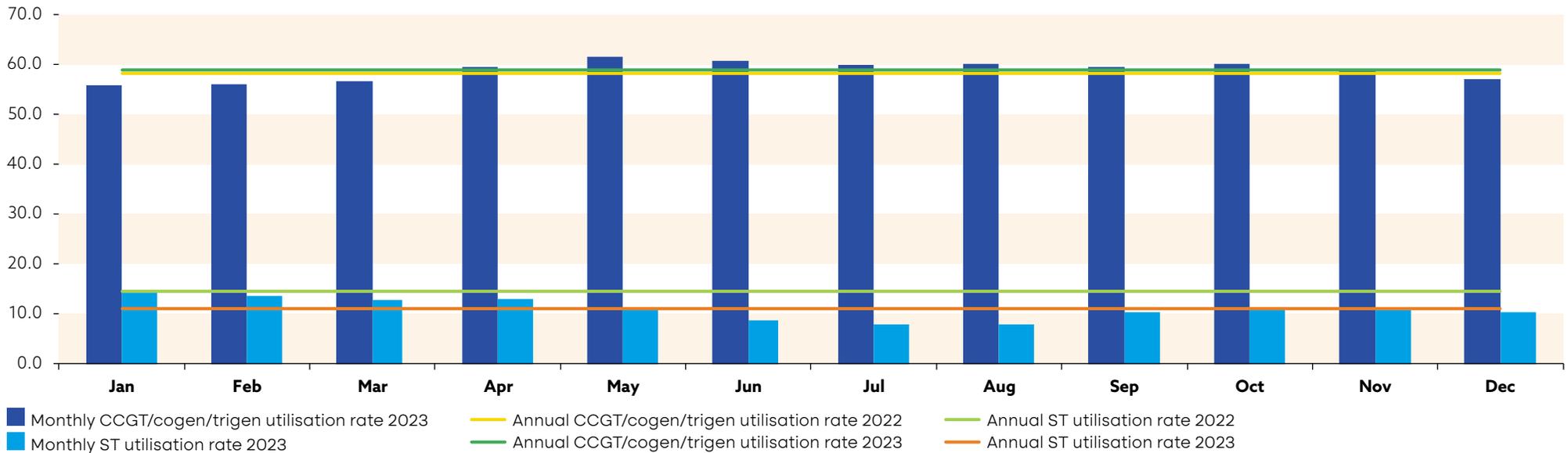
This refers to the generation capacity which is not on maintenance and not being offered to the market. The available generation capacity in excess of offer capacity peaked at 2,927MW in April, while the available CCGT/cogen/trigen capacity in excess of offer capacity peaked at 2,342MW in December, followed by 2,284MW in April.

On a half-yearly comparison, the available generation capacity in excess of offer capacity averaged 25.6 percent higher YOY in the first half of the year and 5.8 percent lower YOY in the second half of the year. Correspondingly, the supply cushion averaged 5.8 percentage points lower YOY in the first half of the year and remained unchanged YOY in the second half of the year, indicating that supply was tighter in the first half of 2023.

# MARKET PERFORMANCE: ENERGY SUPPLY

## Monthly Utilisation and Output-to-capacity Rates by Plant Type 2023

Utilisation Rate (%)



### Mixed movements in utilisation rates

CCGT/cogen/trigen, ST and GT utilisation rate is the ratio of the scheduled energy to the registered capacity.

In 2023, the annual CCGT/cogen/trigen utilisation rate rose 0.5 percentage point to 58.9 percent, while the annual ST utilisation rate dipped 3.5 percentage points to 11.1 percent.

On a monthly basis, the CCGT/cogen/trigen utilisation rate ranged between 55.9 percent in January and 61.6 percent in May, while that of ST ranged between 7.8 percent in July and 14.7 percent in January.

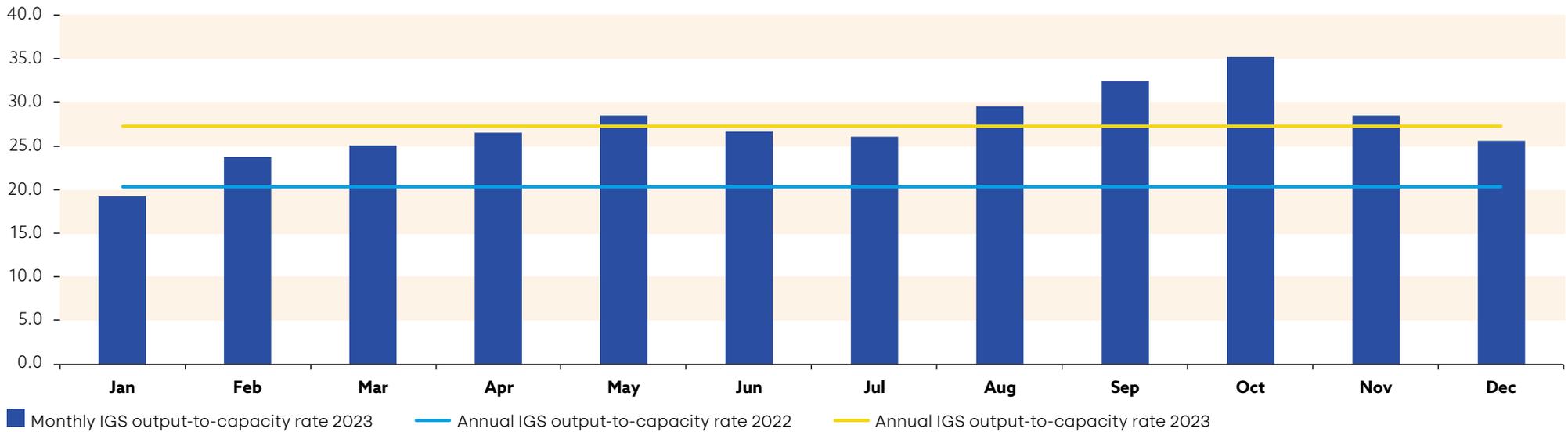
Compared to 2022, the CCGT/cogen/trigen utilisation rate was higher in nine out of the 12 months, with the largest increase of 2.1 percentage points recorded in October. The ST utilisation rate was lower in all months, with the largest decrease of 5.2 percentage points seen in March.

On a separate note, the annual GT utilisation rate dropped to 0.2 percent in 2023, from 1.9 percent in 2022.

## MARKET PERFORMANCE: ENERGY SUPPLY

### Monthly Utilisation and Output-to-capacity Rates by Plant Type 2023

#### Output-to-capacity Rate (%)



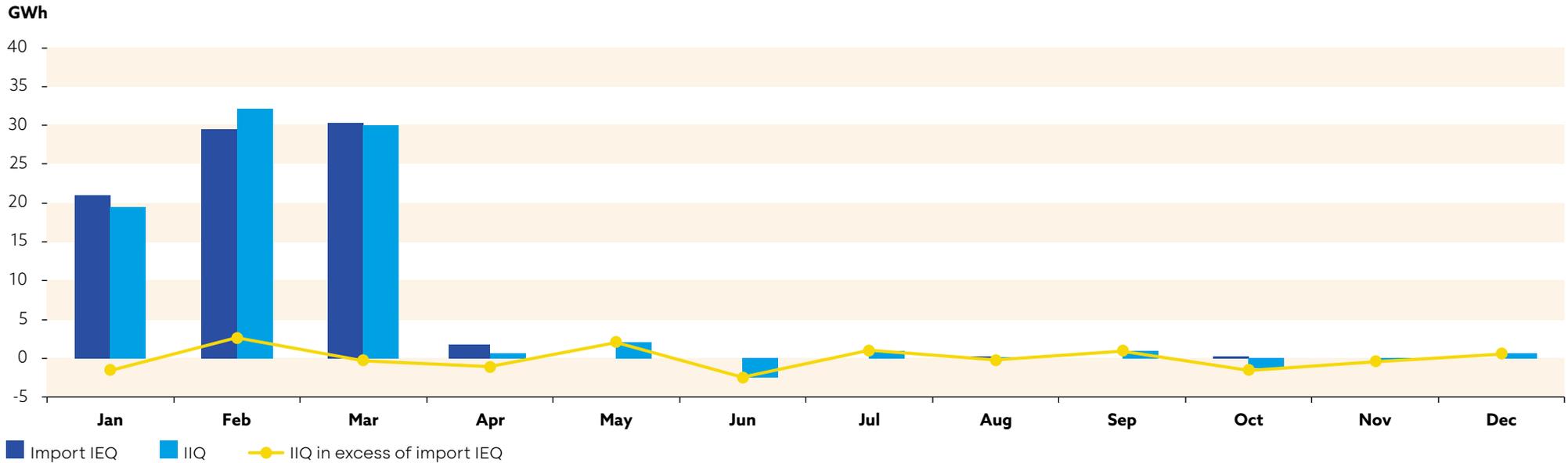
The generation of IGS comprised solely of solar generation facilities. The IGS output-to-capacity rate is the ratio of net injection energy quantity during the solar irradiance periods<sup>19</sup> from 7am to 7pm to the registered capacity.

Typically, the solar generation profile starts low at 7am and reaches its peak in the middle of the day, before dwindling towards 7pm. Taking this profile into account, the annual IGS output-to-capacity rate averaged 27.3 percent, up by 7.0 percentage points from 2022. On a monthly basis, the IGS output-to-capacity rate ranged between 19.3 percent in January and 35.2 percent in October.

<sup>19</sup> Periods used were referenced to Singapore's solar generation profile published on EMA website (Periods 15 to 38).

# MARKET PERFORMANCE: ENERGY SUPPLY

## Monthly Import Generation and Net Imported Intertie Quantities 2023



IEQ = Injection energy quantity | IIQ = Net imported intertie quantity

### Net imported intertie quantity continues to follow import generation quantity closely

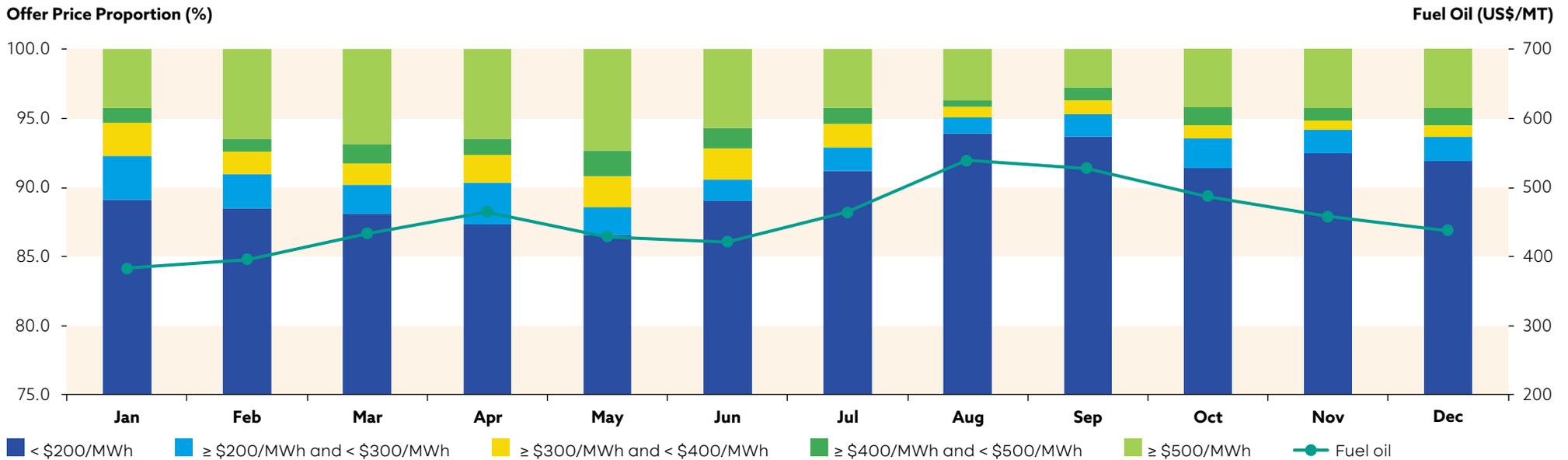
Import generation quantity (Import IEQ) refers to the flow from import facilities. Net imported intertie quantity (IIQ) refers to the flow into or out of the transmission system due to intertie flows.

In the first quarter of 2023, the monthly IIQ was positive and trended closely with the monthly Import IEQ, ranging from 19.5GWh to 32.2GWh. However, the monthly IIQ sank to a lower range of -2.5GWh to 2.1GWh from the second to fourth quarter of 2023. Despite this drop, the monthly IIQ remained positive in most months - only June, October and November recorded negative IIQs. Correspondingly, the monthly Import IEQ plummeted to a range of 0GWh to 1.7GWh from the second to fourth quarter of 2023.

On a monthly basis, the IIQ in excess of the Import IEQ ranged between -2.5GWh and 2.6GWh. The maximum occurred in February, which also had the highest monthly IIQ in the year. The minimum was in June, which was also when the monthly IIQ was the lowest.

## MARKET PERFORMANCE: ENERGY SUPPLY

### Monthly Energy Offer Price Proportion and Fuel Oil Price 2023



#### Energy offer prices move in tandem with fuel oil prices in the first half of the year

In 2023, the daily fuel oil price ranged between US\$365.56 per metric tonne (MT) and US\$547.11/MT. The highest monthly level of US\$539.37/MT was registered in August, while the lowest monthly level of US\$383.30/MT was recorded in January.

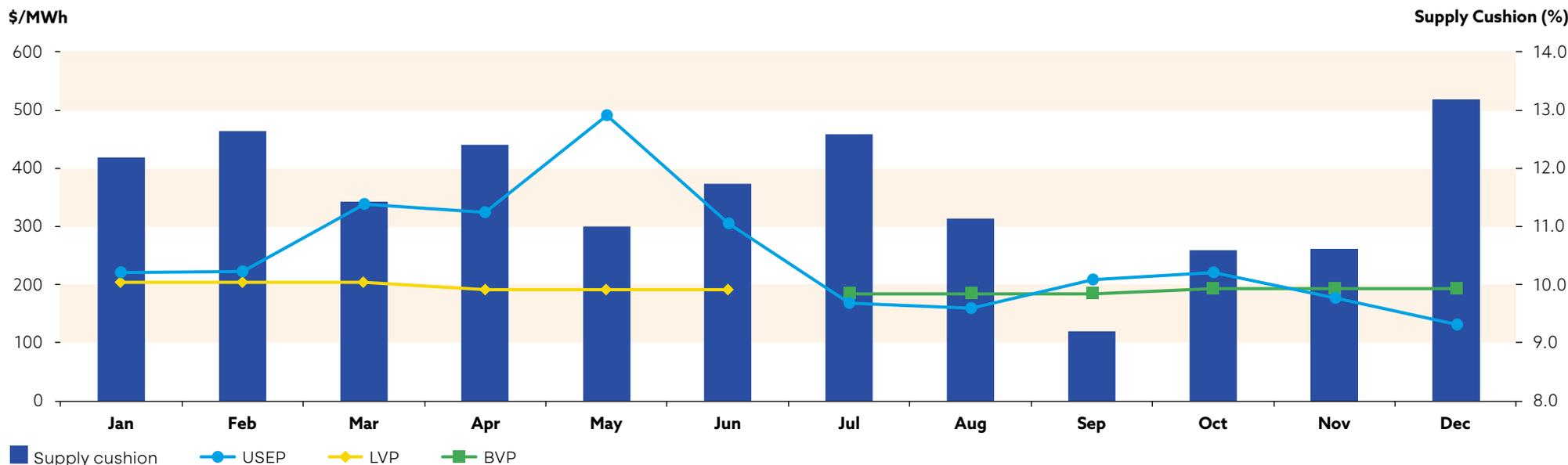
Fuel oil prices climbed from US\$383.30/MT in January to above US\$500.00/MT in August and September, before falling below US\$500.00/MT for the rest of the year. Compared to 2022, which recorded seven months of fuel oil prices above US\$500.00/MT, the fuel oil prices were lower in 2023, underlining the slightly improved fuel oil supply despite ongoing geopolitical conflicts.

In the first half of the year, the proportion of energy offers moved largely in line with fuel oil prices, which ranged between US\$383.30/MT and US\$465.45/MT. The proportion of energy offers below \$200.00/MWh ranged between 86.6 and 89.1 percent, smaller than 90.0 percent.

In the second half of the year, the fuel oil prices ranged between US\$438.06/MT and US\$539.37/MT, higher than in the first half of the year. Despite that, more than 90.0 percent of energy offers were below \$200.00/MWh, with the proportion ranging between 91.2 and 93.9 percent. This indicates that there were more energy offers which were less expensive in the second half of the year. This can be attributed to the introduction of the TPC mechanism and the new vesting regime framework which took effect from 1 July 2023.

# MARKET PERFORMANCE: ENERGY PRICES

## Monthly USEP, Vesting Prices and Supply Cushion 2023



LNG Vesting Price was used from January to June 2023.  
 Base Vesting Price was used from July to December 2023.

### USEP remains above vesting prices benchmark for most months

In 2023, the difference between the lowest monthly USEP of \$131.42/MWh in December and the highest monthly USEP of \$492.09/MWh in May was \$360.68/MWh, up from \$272.83/MWh in 2022.

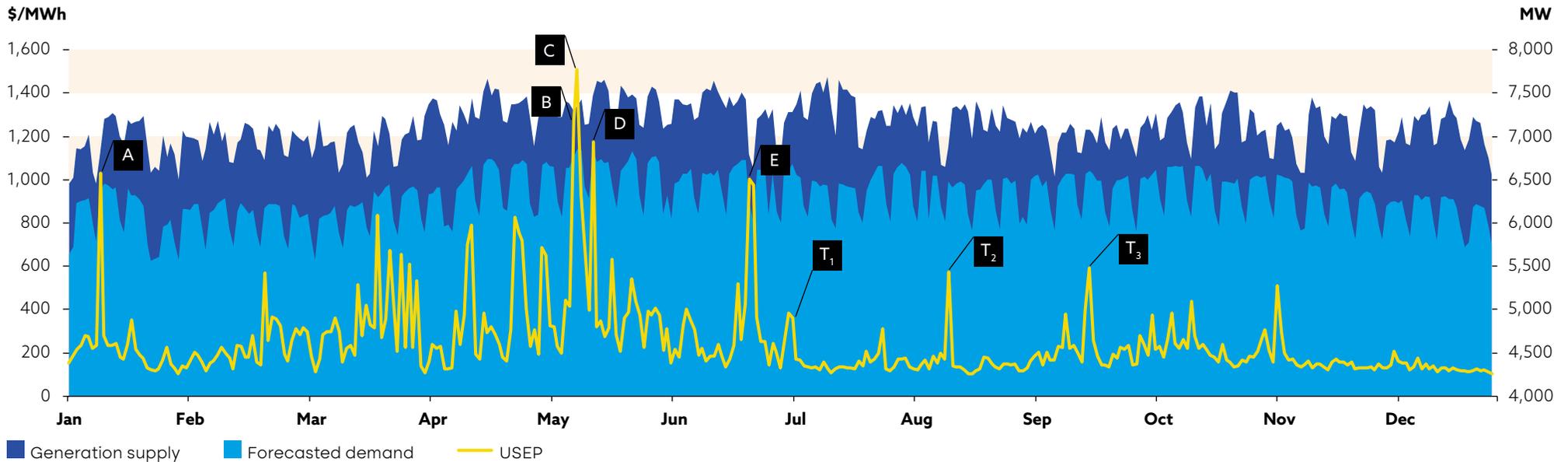
In the first half of the year, the average USEP registered above the vesting prices in all months. The average USEP was \$119.79/MWh higher than the average LNG Vesting Price (LVP) in the first half of the year. The largest absolute gap between the monthly USEP and the monthly LVP was in May, when the USEP was \$301.56/MWh greater than the LVP, while the smallest absolute gap was observed in January when the USEP was \$16.53/MWh greater than the LVP.

In contrast, the USEP trended closer to the Base Vesting Price (BVP) in the second half of the year, after the introduction of the new vesting regime framework from 1 July 2023. The gap between the monthly USEP and the monthly BVP was narrower in the second half of the year. The largest absolute gap was in December, when the USEP was \$61.22/MWh lower than the BVP, while the smallest absolute gap was observed in November when the USEP was \$14.91/MWh lower than the BVP.

The monthly supply cushion was below 13.0 percent in all months except December. The supply cushion averaged 11.6 percent in 2023, 2.9 percentage points thinner than 2022's and was the thinnest supply cushion has been since the market started.

## MARKET PERFORMANCE: ENERGY PRICES

### Daily USEP, Forecasted Demand and Generation Supply 2023



The USEP averaged \$318.84/MWh and \$177.37/MWh in the first and second halves of the year respectively. Compared to the first half of the year, the coefficient of variance of USEP fell 17.1 percent in the second half. This indicates that the USEP was less volatile in the second half of 2023 after the implementation of the TPC mechanism and new vesting regime. The key observations on the USEP fluctuations in 2023 are as follows:

**Point A:** On 9 January (Monday), the USEP averaged \$1,027.58/MWh. Tight supply conditions, with 11 units on maintenance<sup>20</sup> and a forced outage of one ST unit in Period 15, elevated the USEP to a range of \$500.34/MWh to \$3,960.68/MWh from Periods 15 to 44.

The supply cushion ranged between 1.0 and 8.0 percent during these periods. Contingency reserve shortfall was observed from Periods 17 to 19, 31 to 35, 38 to 39, and 43, while regulation shortfall was observed from Periods 17, 18, 20, and 37 to 41. Demand Response (DR) curtailment was scheduled from Periods 20 to 22, and 30 to 31. The PSO advised that the power system was in a high-risk operating state in Periods 17, 31, 37, and 43, and in an emergency operating state in Periods 18, 32, and 38. The power system returned to a normal operating state in Periods 21, 36, 42, and 44.

**Point B:** On 10 May (Wednesday), the USEP averaged \$1,270.95/MWh, while the forecasted demand averaged 6,756MW, the ninth highest daily level since the market started. There were eight units on maintenance. Due to higher demand, the USEP was elevated to a range of \$521.07/MWh to \$3,003.48/MWh in Periods 16 to 24 and Periods 29 to 45. The supply cushion ranged between 4.3 and 7.3 percent during these periods. DR curtailment was scheduled from Periods 27 to 37.

**Point C:** On 11 May (Thursday), the USEP averaged \$1,508.01/MWh, the highest daily USEP for 2023. Furthermore, the forecasted demand averaged 6,846MW, a historic daily high.

With similar supply conditions and even stronger demand than the day before, 42 periods' USEPs were cleared above \$500.00/MWh, ranging between \$507.84/MWh and \$3,340.15/MWh. The supply cushion ranged between 2.9 and 9.8 percent during these periods. Contingency reserve shortfall occurred in Periods 18, 30, and 37 to 42, while regulation shortfall occurred in Periods 16 and 37 to 42. DR curtailment was scheduled from Periods 28 to 36. The PSO advised that the power system was in a high-risk operating state in Periods 16, 18 and 37 and in an emergency operating state in Period 18. The power system returned to a normal operating state in Periods 17, 19 and 43.

<sup>20</sup> Includes CCGT, EGs and Import units on full and partial, planned and unplanned maintenance.

## MARKET PERFORMANCE: ENERGY PRICES

**Point D:** On 15 May (Monday), the USEP averaged \$1,174.41/MWh, while the forecasted demand averaged 6,819MW, the fourth highest daily level since the market started. Only two units were on maintenance. The strong demand sent USEP soaring above \$500.00/MWh in 30 periods, ranging between \$506.12/MWh and \$3,593.76/MWh. The supply cushion ranged between 2.2 and 9.0 percent during these periods. Notably, the forecasted demand in Periods 33, 34 and 32 were ranked the top three periodic forecasted demand levels, in that order, since the market started. Contingency reserve shortfall occurred in Period 26 and regulation shortfall occurred in Period 37. DR curtailment was scheduled from Periods 21 to 23. The PSO advised that the power system was in a high-risk operating state in Periods 26 and 37 and returned to a normal operating state in Periods 27 and 38.

**Point E:** On 24 June (Saturday), the USEP averaged \$1,000.38/MWh. Six units were on maintenance. Following a forced outage of one CCGT unit in Period 35, the PSO advised that contingency reserve was activated in the same period and was restored in the next period. The supply cushion contracted to a range of 0.2 to 4.5 percent from Periods 36 to 45. As a result, energy shortfall occurred in Periods 37, 41 to 43, contingency reserve shortfall occurred in Periods 36 to 37 and 40 to 44 and regulation shortfall occurred in Periods 37, and 39 to 41. The USEP spiked between \$658.63/MWh and \$4,500.00/MWh over

Periods 36 to 45. DR curtailment was scheduled in Periods 32, and 38 to 46. The PSO advised that the power system was in a high-risk operating state in Periods 36 and 39 and at an emergency operating state in Periods 37 and 40. The power system returned to a normal operating state in Periods 38 and 45.

**Point T<sub>1</sub>:** On 5 July (Wednesday), seven units were on maintenance. In Period 33, the supply cushion thinned to 2.8 percent due to stronger demand and weaker supply. As a result, the USEP spiked to \$2,503.66/MWh. The TPC was triggered in Period 33 when the Moving Average Price (MAP)<sup>21</sup> of \$521.99/MWh crossed the Moving Average Price Threshold (MAPT)<sup>22</sup> of \$500.85/MWh. The TPC was activated from Period 34, 5 July to Period 33, 6 July. The USEP was capped at the TPC energy price cap<sup>23</sup> for four periods (5 July, Periods 34 to 37). Without the TPC activation, the daily USEP would have averaged 17.4 percent higher at \$434.00/MWh on 5 July.

**Point T<sub>2</sub>:** On 14 August (Monday), eight units were on maintenance. In Period 26, energy shortfall occurred and the USEP spiked to the cap of \$4,500.00/MWh as the supply cushion thinned to 2.4 percent due to stronger demand and weaker supply. The PSO advised that the power system was at a high-risk operating state in Period 26. The power system returned to a normal operating state from Period 27 onwards.

The USEP continued to clear above \$1,000.00/MWh in Periods 28, and 30 to 33. In Period 33, the MAP of \$564.08/MWh crossed the MAPT of \$530.64/MWh and the TPC was activated from the next period, Period 34, 14 August to Period 33, 15 August. Two periods of USEP (14 August, Periods 34 and 35) were capped at the TPC energy price cap. Notably, Period 35's USEP was lower than the TPC energy price cap as the nodal prices at some withdrawal nodes were below the TPC energy price cap, resulting in a slightly lower USEP at \$530.32/MWh. Without the TPC activation, the daily USEP would have averaged 4.5 percent higher at \$598.98/MWh on 14 August.

**Point T<sub>3</sub>:** On 19 September (Tuesday), seven units were on maintenance. The forecasted demand surged to a range of 7,123MW to 7,317MW from Periods 32 to 36. Correspondingly, the supply cushion contracted to a range of 0.1 to 3.6 percent. As a result, the USEP spiked to a range of \$3,184.78/MWh to \$4,500.00/MWh from Periods 32 to 35. Energy shortfall was recorded in Period 33 and contingency reserve shortfall was observed in Periods 35 and 36. The PSO advised that the power system was in a high-risk operating state in Period 33 and in an emergency operating state in Period 34. The power system returned to a normal operating state from Period 36 onwards. The MAP of \$590.40/MWh crossed the MAPT of \$584.01/MWh in Period 35 and TPC was activated from the next period, Period 36.

On 20 September (Wednesday), a forced outage of one CCGT unit in Period 28 caused the supply to tighten, resulting in energy shortfalls from Periods 30 to 34. DR curtailment was scheduled from Periods 31 to 36. The PSO advised that the power system was in a high-risk operating state in Period 30 and in an emergency operating state in Period 31. The power system returned to a normal operating state from Period 36 onwards.

In Period 35, the MAP of \$831.10/MWh continued to stay above the MAPT. As such, the TPC continued to be activated, until Period 30, 21 September (Thursday) when the MAP of \$578.86/MWh finally fell below the MAPT. Eight periods of USEP were capped at the TPC energy price cap between 19 and 20 September. Without the TPC activation, the daily USEP would have averaged 8.8 percent higher at \$647.26/MWh on 19 September and 64.5 percent higher at \$721.52/MWh on 20 September.

<sup>21</sup> Moving Average Price (MAP) refers to the moving average price of 48 periods.

<sup>22</sup> Moving Average Price Threshold (MAPT) is set by the Energy Market Authority (EMA) to be a multiplier times CCGT Long Run Marginal Cost (LRMC).

<sup>23</sup> USEP is capped at the TPC energy price cap when the Reference USEP (RUSEP) is above the TPC energy price cap. RUSEP refers to the uncapped counterfactual USEP when the Temporary Price Cap (TPC) is in effect.

## MARKET PERFORMANCE: DEMAND RESPONSE

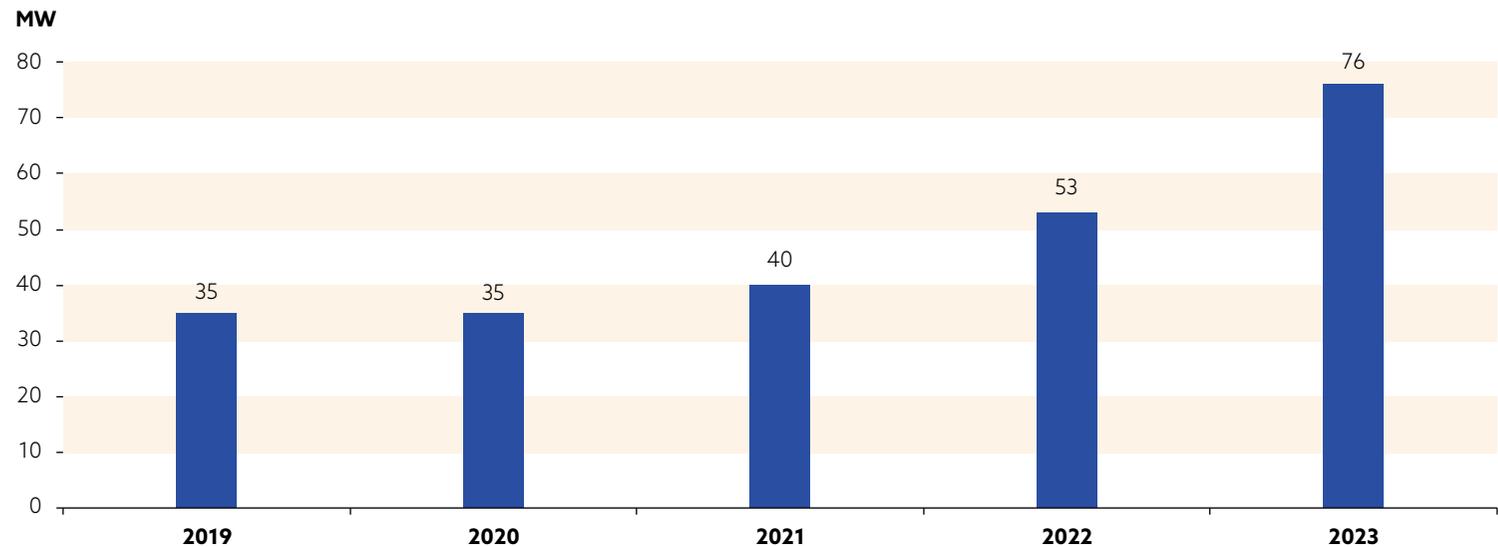
### Demand Response registered curtailment capacity grows significantly

The DR programme was introduced in 2016 to enable contestable consumers to participate directly in the wholesale market by reducing their electricity demand voluntarily in response to market conditions. This is particularly during periods of high wholesale market prices or when the supply condition is tight.

To encourage more participation in the DR programme, a Demand Side Management (DSM) Sandbox was introduced from 1 January 2023 to 31 December 2024. During the sandbox period, the threshold for non-compliance is lowered from 95 to 80 percent. The penalty regime is further relaxed such that no penalties are incurred for the first two instances of under-delivery. Upon the fifth instance of under-delivery, the DR participant will be administratively suspended from the sandbox.

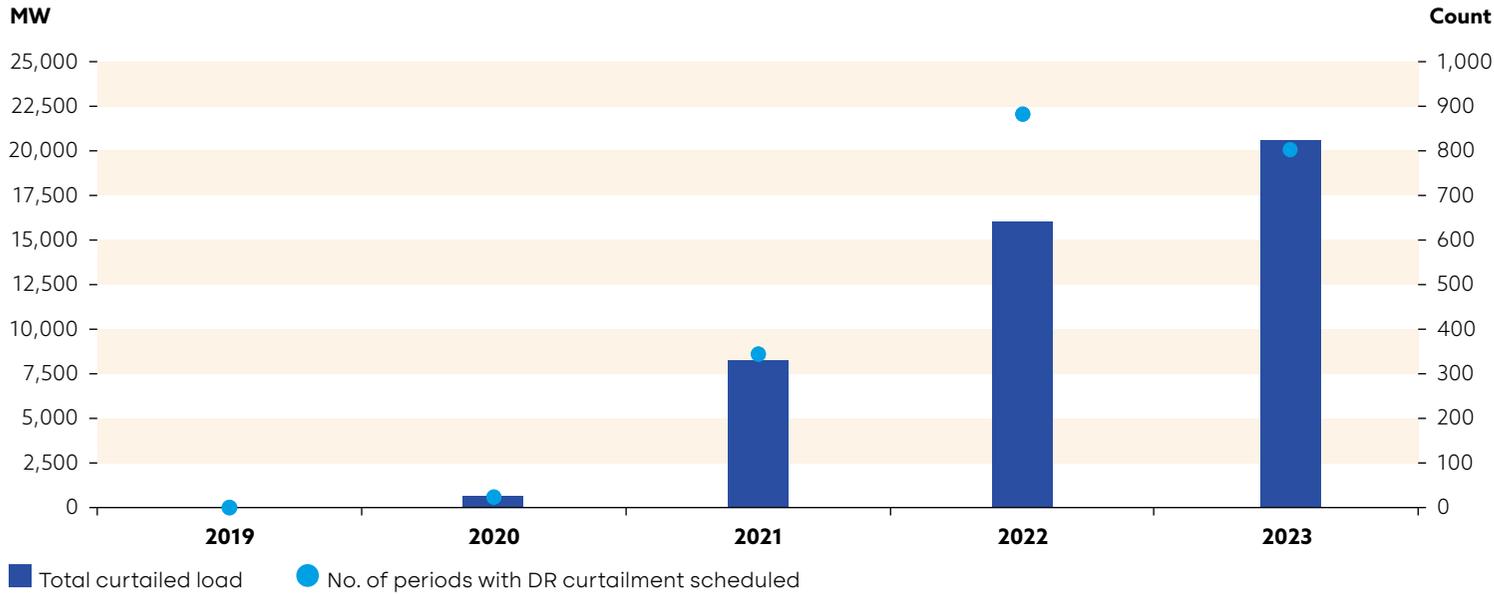
The DR registered curtailment capacity has been growing since 2020. With the introduction of the sandbox in 2023, more DR facilities were registered in the market. As at 31 December 2023, the number of DR facilities increased from four facilities in 2022 to seven facilities, while the number of DR providers remained at three. Correspondingly, the DR registered curtailment capacity rose 43.4 percent YOY to 76MW.

### Annual Demand Response Registered Curtailment Capacity 2019–2023



# MARKET PERFORMANCE: DEMAND RESPONSE

## Annual Demand Response Curtailment Scheduled 2019-2023



### Total curtailed load rises despite fewer periods with DR curtailment

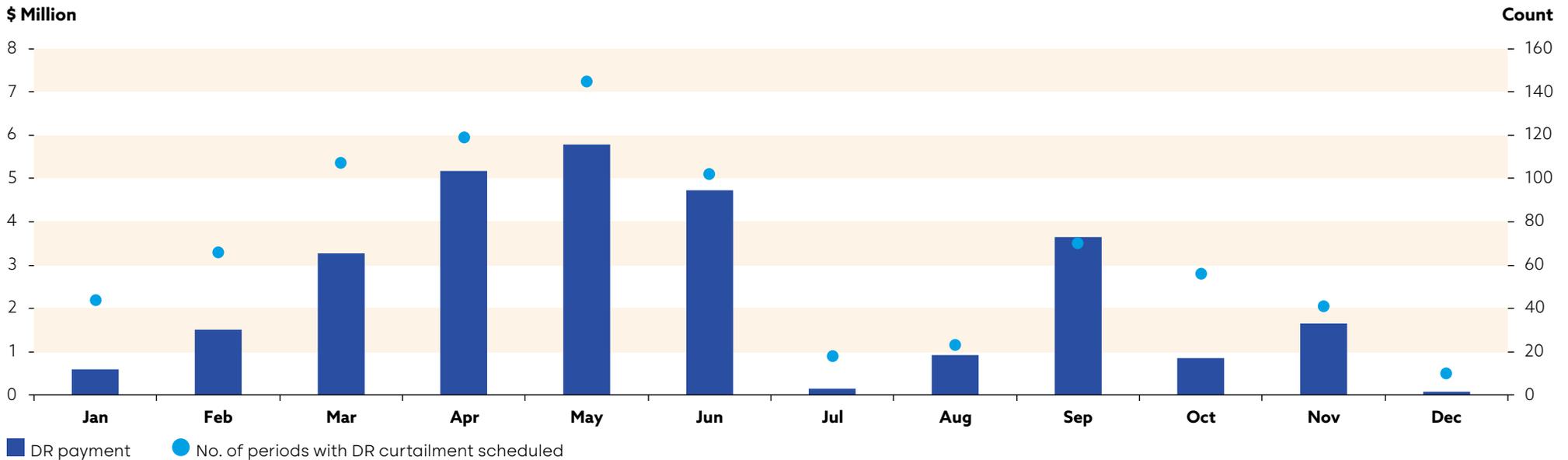
The number of periods with DR curtailment decreased to 801 in 2023 from 883 in 2022. This was in line with a fall in the number of trading periods with USEP above \$500.00/MWh to 895 in 2023 from 1,235 in 2022.

On a half-yearly basis, there were 583 periods with DR curtailment in the first half of the year, more than the 218 such periods in the second half of the year. This was in line with the higher daily average USEP observed in the first half of the year.

The total curtailed load rose 28.4 percent to 20,547MW in 2023, corresponding with the growth in the DR registered curtailment capacity.

## MARKET PERFORMANCE: DEMAND RESPONSE

### Monthly Demand Response Payment 2023



#### DR payment amount increases with higher load curtailed

Compared to 2022, the spread between the Counterfactual Uniform Singapore Energy Price (CUSEP) and the USEP (or the Reference USEP (RUSEP)<sup>24</sup> during TPC activations) in 2023 widened to between -\$1,352.86/MWh and \$3,863.40/MWh and averaged higher at \$176.39/MWh.

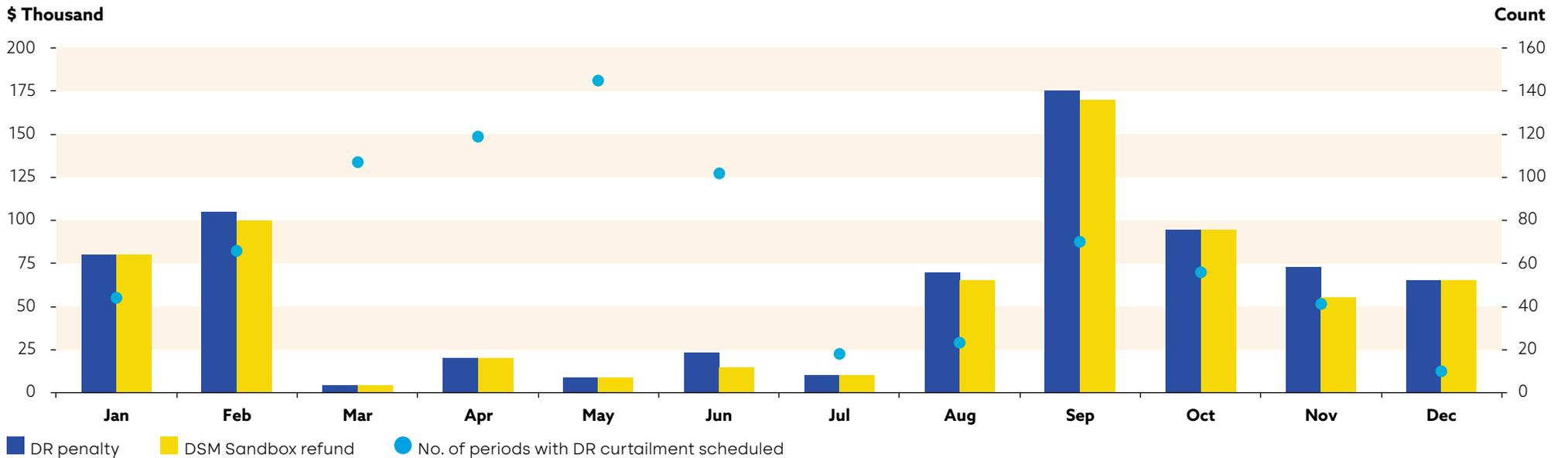
This indicates that with each MW, consumers benefitted more from the higher estimated average cost savings of \$176.39/MWh in 2023, compared to \$75.47/MWh for each MW in 2022.

The annual DR payment amounted to \$28.4 million in 2023, 33.0 percent up from \$21.3 million in 2022. There were DR payments in all 12 months in 2023, as there had been in 2022. May was the month with the largest number of periods with DR curtailment, 145, and the highest DR payment of \$5.8 million.

<sup>24</sup> From 1 July 2023, when the TPC mechanism was introduced, the Reference USEP (RUSEP) was used as a comparison.

# MARKET PERFORMANCE: DEMAND RESPONSE

## Monthly Demand Response Penalty and Demand Side Management Sandbox Refund 2023



### DR penalty amount increases, coinciding with the Demand Side Management Sandbox

Before accounting for DR penalty refunds under the DSM Sandbox, the annual DR penalty amount surged to \$728,489.57 in 2023, more than seven-folds of the \$96,253.91 in 2022. The DR penalty amount peaked in September at \$175,000.00, which was also the highest monthly DR penalty amount since 2019. DR penalties were imposed in all months of 2023, as compared to six months in 2022.

This increase in DR penalty amount (under the 95% compliance threshold) coincided with the relaxed penalty regime under the DSM Sandbox, under which DR participants can request for a refund of the DR penalty imposed. The total annual DSM Sandbox refund amount was \$687,691.62 in 2023, which accounts for 94.4 percent of the total annual DR penalty amount. After accounting for DR penalty refunds, the net 2023 annual DR penalty amount is \$40,797.95, 57.6 percent lower than that of 2022.

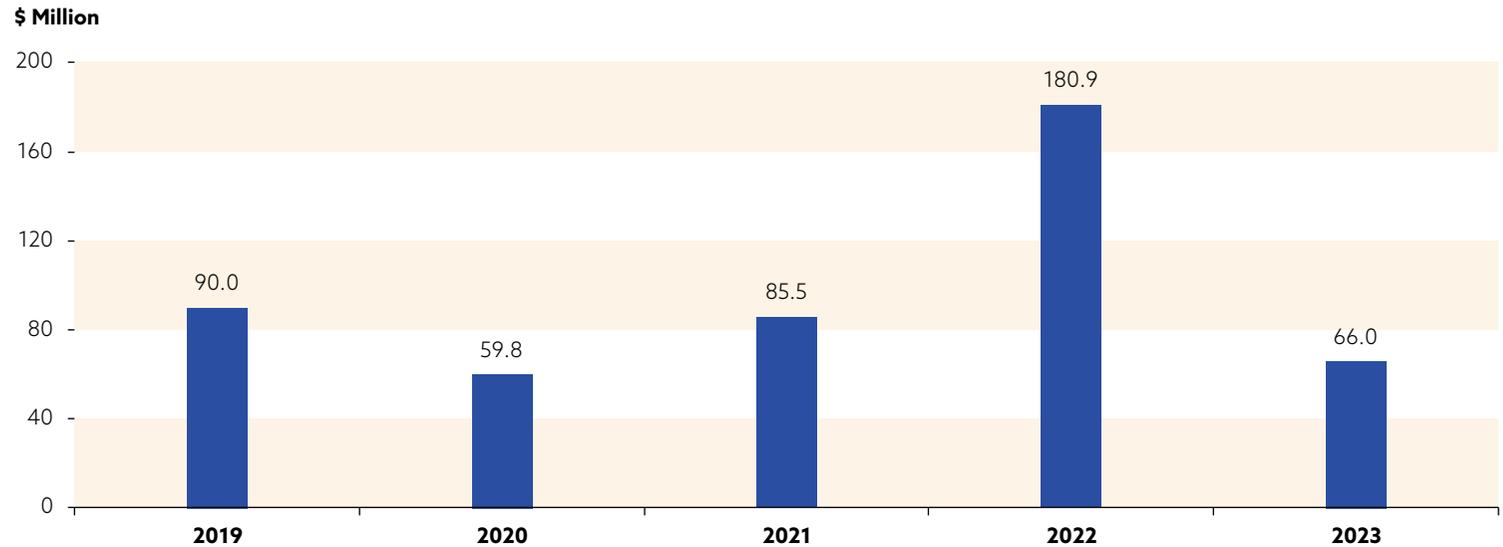
## MARKET PERFORMANCE: ANCILLARY MARKETS

### Reserve payment reverses upward trend

Reserves serve as a backup in the electricity market for unexpected outages caused by generators tripping. The amount of reserves required is determined by the amount needed should the largest online generator trip. In the NEMS, two reserve products are traded: primary and contingency reserves. Each reserve has its own price and response time, the latter being nine seconds for primary reserve and 10 minutes for contingency reserve. The generators bear the cost of procuring the reserves.

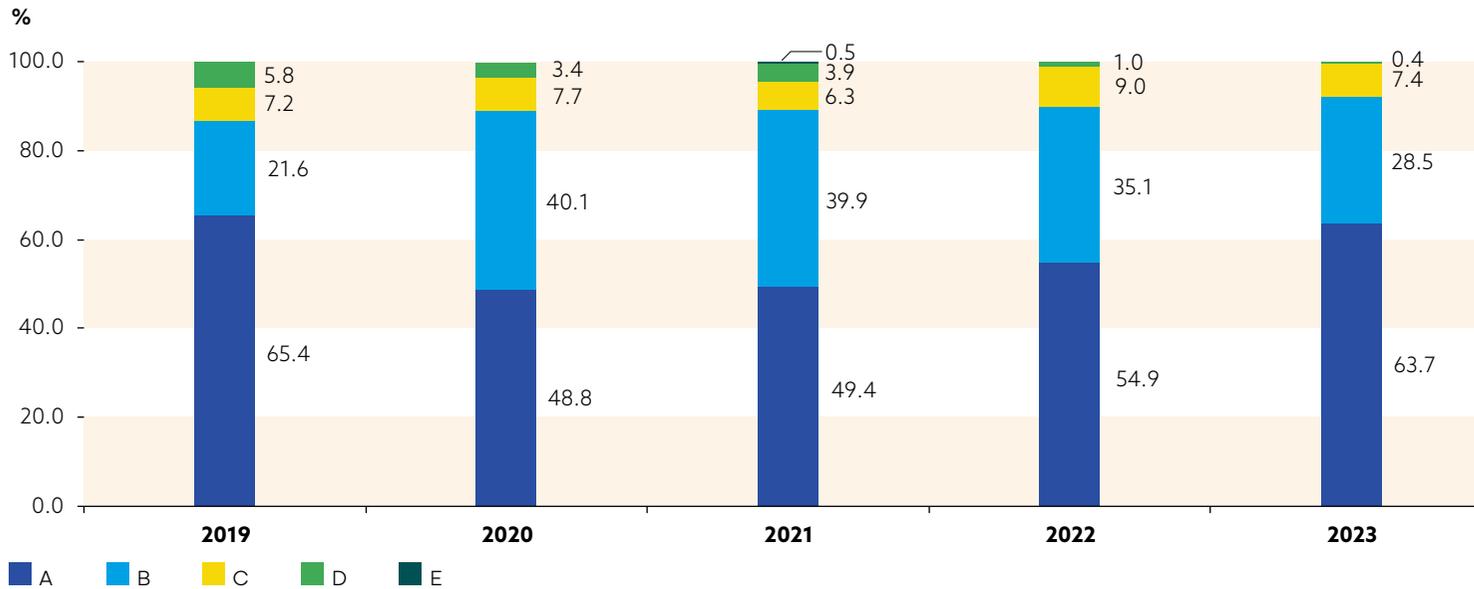
Compared to 2022, which recorded the highest reserve payment since the market started, reserve costs decreased 63.5 percent to \$66.0 million. This was primarily driven by declines in both contingency reserve prices and the contingency reserve requirement. The contingency reserve price fell \$19.60/MWh to \$16.51/MWh and the contingency reserve requirement decreased to 395MW from 496MW.

### Annual Reserve Payment 2019-2023



## MARKET PERFORMANCE: ANCILLARY MARKETS

### Reserve Provider Group Effectiveness for Primary Reserve Class (Aggregate) 2019-2023



Statistics exclude IL providers.

### Higher overall responsiveness of reserve providers

Reserve providers in the NEMS are classified into five groups: Group A reflects reserve providers with the highest level of responsiveness and Group E reflects those with the lowest level of responsiveness. A higher level of responsiveness attracts a higher proportion of reserve price.

In 2023, some of the reserve providers in Groups B, C and D moved into Group A. The percentage of reserve providers in Group A increased 8.8 percentage points, while that for Groups B, C and D decreased 6.6, 1.6 and 0.6 percentage points respectively. As had been the case in 2022, there were no reserve providers in the Group E category in 2023.

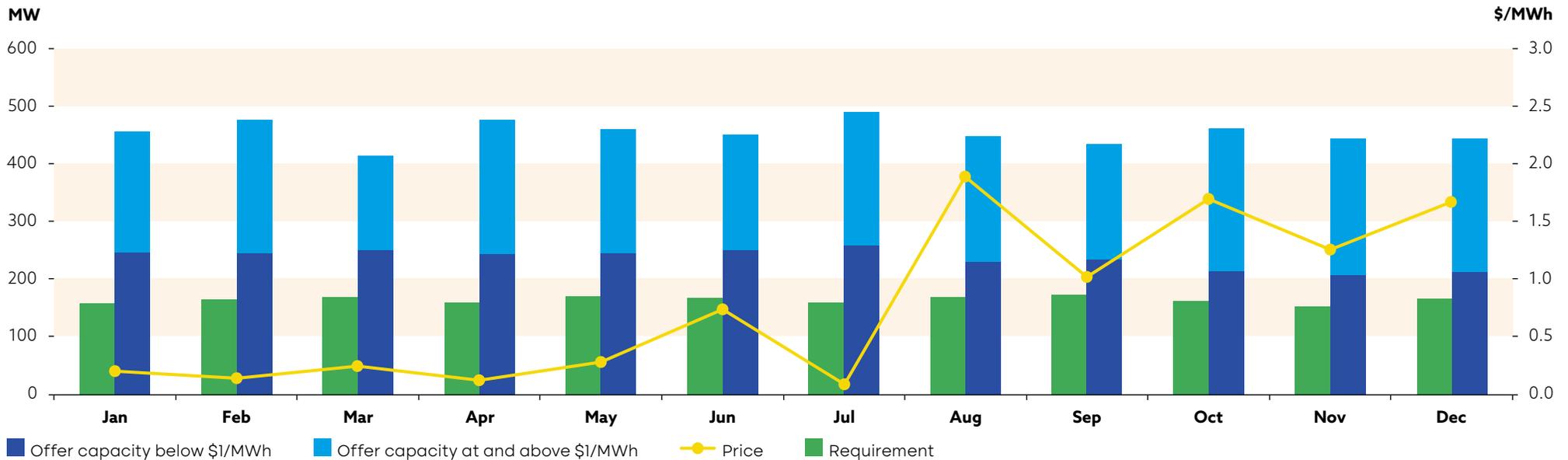
Notably, Group A's proportion of 63.7 percent is the second highest since the market started, while Group D recorded the lowest proportion since the market started, of 0.4 percent.

Overall, the reserve providers' effectiveness improved in 2023. The proportion of reserve providers in the more responsive Groups A and B improved to 92.2 percent from 90.0 percent, while the proportion of reserve providers in the less responsive Groups C, D and E contracted to 7.8 percent from 10.0 percent.

All contingency reserve providers were classified in Group A.

## MARKET PERFORMANCE: ANCILLARY MARKETS

### Monthly Primary Reserve Price, Requirement and Supply 2023



#### Lower primary reserve prices with no occurrence of shortfall

The annual average primary reserve price decreased to \$0.78/MWh in 2023 from \$1.64/MWh in 2022. The lowest monthly average of \$0.08/MWh was observed in July and the highest monthly average price was \$1.89/MWh in August, followed by \$1.70/MWh in October. The higher prices from August to December were due to fewer offers in the cheaper tranches.

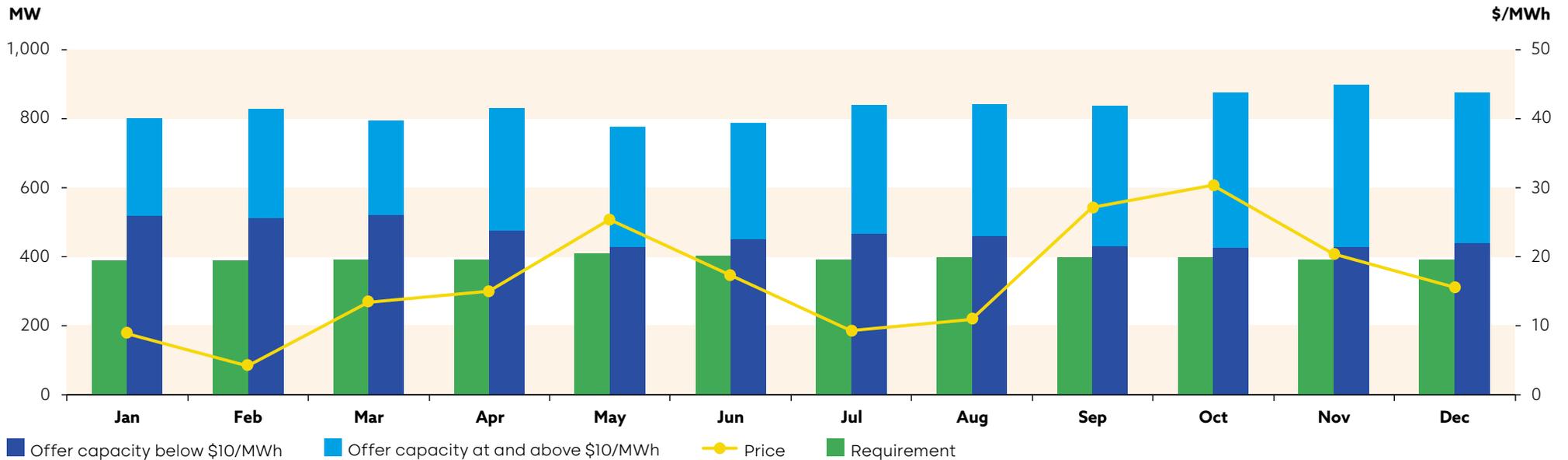
The annual average primary reserve requirement increased marginally to 164MW in 2023 from 163MW in 2022, while the annual primary reserve offers grew 7.1 percent to 454MW. On a monthly basis, the primary reserve requirement ranged between 152MW and 172MW, with the lowest level seen in November and the highest level in May. The monthly primary reserve offers averaged below 500MW for all months. The monthly primary reserve offers were lowest in March at 414MW and highest in July at 490MW.

The proportion of primary reserve offers below \$1.00/MWh ranged between 46.5 and 60.4 percent in 2023.

As had been the case in 2022, there were no inertia disconnections and adjustments to the Risk Adjustment Factor (RAF) in 2023. The RAF remained at 1.0. There was no primary reserve shortfall in 2023, while there had been seven periods of primary reserve shortfall in 2022.

## MARKET PERFORMANCE: ANCILLARY MARKETS

### Monthly Contingency Reserve Price, Requirement and Supply 2023



#### Contingency reserve price drops on lower requirement and fewer instances of shortfalls

The annual average contingency reserve price plummeted to \$16.51/MWh in 2023 from \$36.11/MWh in 2022. The highest monthly average price of \$30.27/MWh was observed in October while the lowest was registered in February at \$4.20/MWh.

The annual average contingency reserve requirement declined 20.4 percent from 496MW to 395MW, while the annual average contingency reserve offers fell 14.9 percent to 832MW. The lower annual contingency reserve requirement and price can be attributed to the lower RAF, which was revised down to 1.0 from 8 July 2022. The RAF remained at 1.0 in 2023.

On a monthly basis, the contingency reserve requirement hovered below 400MW for all months, except May and June. The lowest contingency reserve requirement of 389MW was observed in January and February, while the highest was seen in May at 410MW. The monthly contingency reserve offers were highest in November at 899MW and lowest in May at 777MW. In the first half of the year, the proportion of contingency reserve offers below \$10.00/MWh ranged between 55.1 and 65.6 percent. In contrast, it ranged between 47.8 and 55.8 percent in the second half of the year, resulting in the higher contingency reserve prices recorded in the second half of the year.

The total number of periods with contingency reserve shortfall dropped drastically to 81 in 2023, from a historic high of 680 in 2022. The first half of the year recorded 66 periods of contingency reserve shortfall, while the second half of the year recorded 15 such periods. This was in line with the higher average USEP and tighter supply seen in the first half of the year.

## MARKET PERFORMANCE: ANCILLARY MARKETS

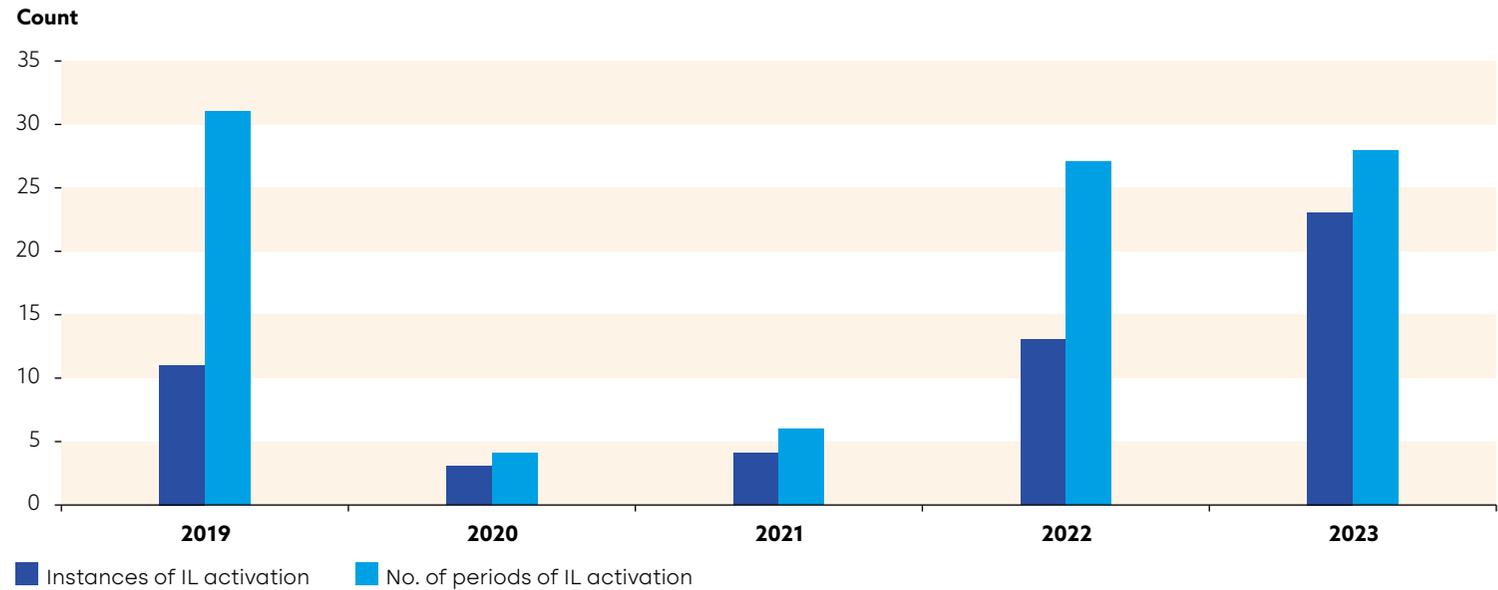
### More frequent but shorter duration of interruptible load activation

As of 31 December 2023, there was no registered capacity for interruptible load (IL) for primary reserve. For contingency reserve, the total IL registered capacity remained at 24.9MW.

In 2023, the number of IL activations for contingency reserve increased to 23 from 13, while the total number of periods when IL was activated for contingency reserve increased to 28 from 27. This meant that 0.2 percent of the total number of periods in 2023 saw IL activation, the same proportion as in 2022.

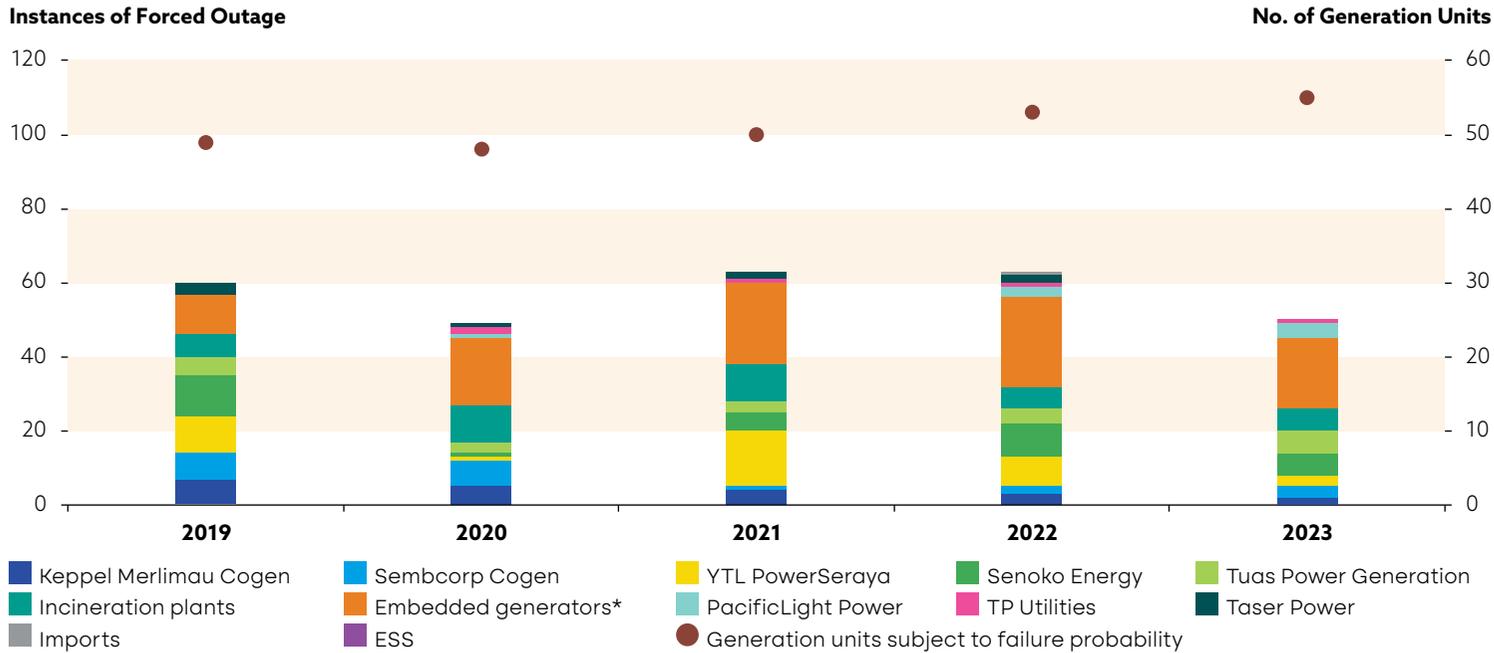
IL was activated most frequently in June – a total of eight instances. The longest continuous stretches of IL activation lasted two periods each, on 16 March, 3 April, 24 July and 23 August.

### Annual Interruptible Load Activations for Contingency Reserve Market 2019–2023



# MARKET PERFORMANCE: ANCILLARY MARKETS

## Annual Forced Outages by Generation Companies 2019-2023



### Total number of forced outages decreases

In 2023, 55 generation units were subject to failure probability and 50 forced outages occurred, down from 63 in 2022. With the exception of three, the generation companies experienced either the same number or fewer forced outages in 2023, compared to 2022.

The number of generation units refers to the number of generation units registered in the NEMS which are subject to reserve responsibility share.  
 \* Embedded generators exclude TP Utilities.

## MARKET PERFORMANCE: ANCILLARY MARKETS

### Reliability of CCGT/cogen/trigen and GT improves while that of ST drops

The average failure probability for a Generation Registered Facility (GRF) is the probability that after being dispatched by the PSO for a settlement interval, the GRF will either cease operating, disconnect from the transmission system, or both, during that settlement interval, even if no other GRF fails. A generation facility with a lower failure probability will be allocated less reserve cost compared to one with a higher failure probability.

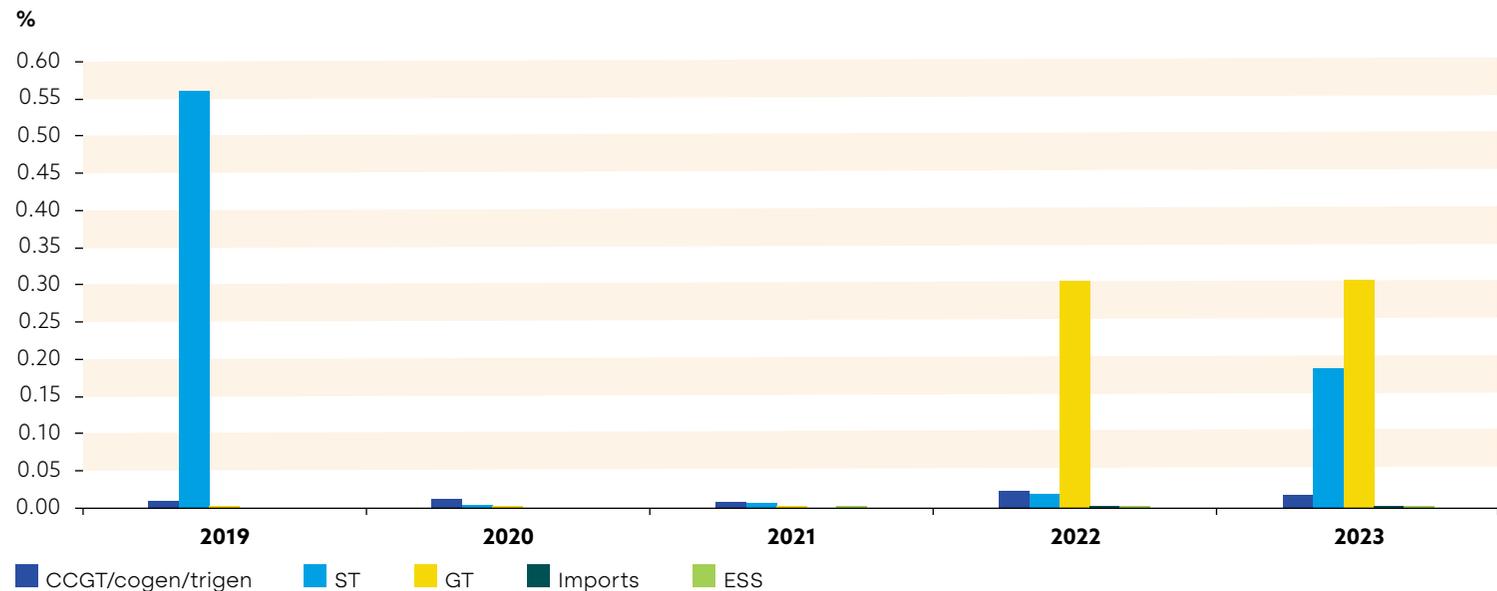
In short, failure probability is a measure of the reliability of the generation facility. The lower a GRF's failure probability, the more reliable it is considered to be.

CCGT/cogen/trigen, ST and GT facilities had average failure probabilities of 0.017, 0.188 and 0.300 percent respectively in 2023.

Compared to 2022, the failure probability of CCGT/cogen/trigen and GT facilities declined while that of ST facilities rose. The average failure probability of energy storage systems and import facilities remained at 0.001 percent in 2023.

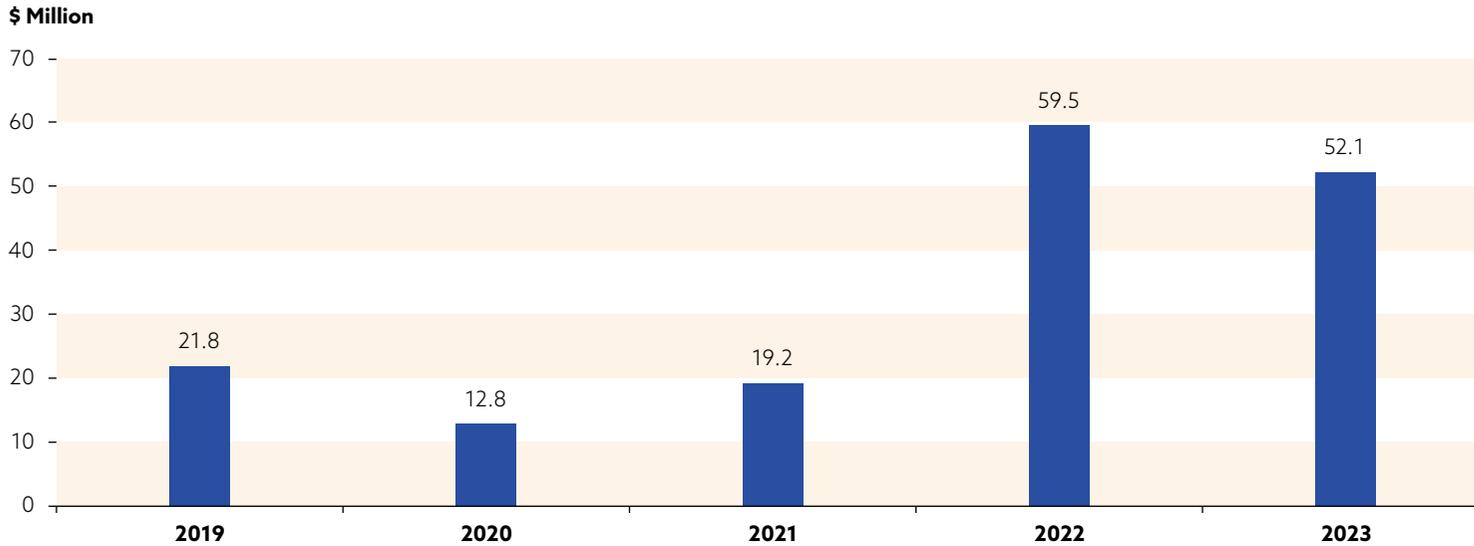
The performance of CCGT/cogen/trigen and GT facilities was aligned with the fewer forced outages they had experienced in the year. On the other hand, ST facilities also saw fewer forced outages but had a higher average failure probability due to sharp increases in failure probabilities of a few of them. Overall, the average failure probabilities were higher for 18 facilities and lower for 24 facilities.

### Average Failure Probability 2019–2023



## MARKET PERFORMANCE: ANCILLARY MARKETS

### Annual Regulation Payment 2019-2023



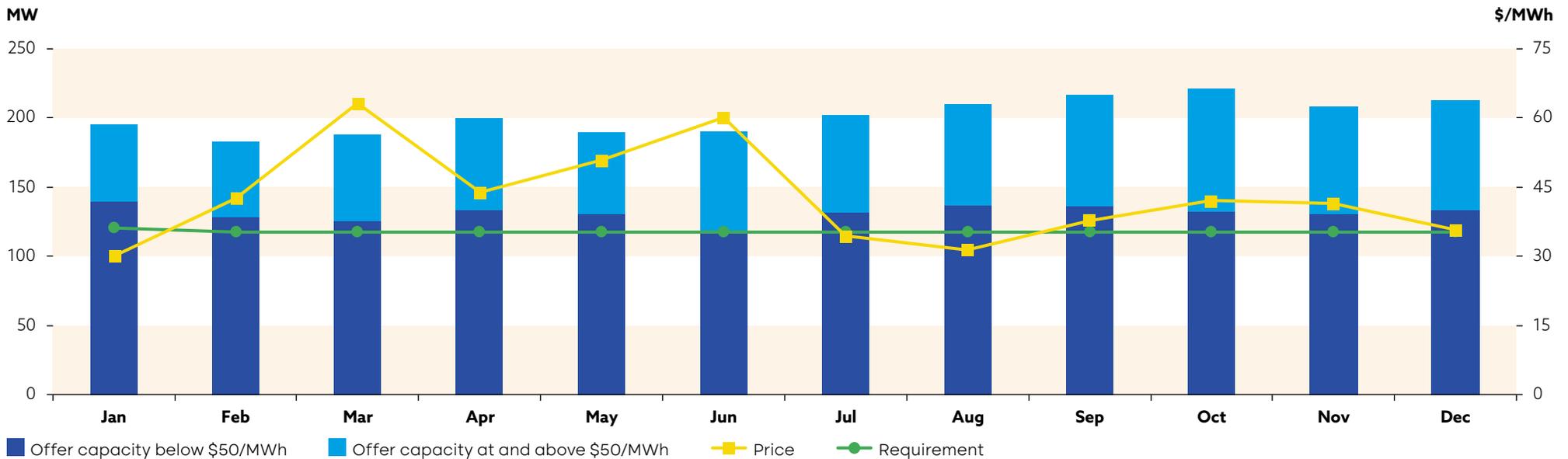
### Regulation payment falls after reaching its 12-year peak

Regulation payment declined 12.4 percent to \$52.1 million in 2023. This was in line with the decrease in regulation requirement to 117MW from 120MW, which took effect on 1 February 2023, as well as a 11.4 percent decline in regulation price to \$42.71/MWh.

Compared to 2022, monthly regulation payment decreased between \$0.1 million and \$5.4 million for six months in the year. The largest decline was in July as the highest monthly regulation payment of \$8.9 million was recorded in July 2022. The highest monthly regulation payment in 2023 was \$6.6 million in March.

## MARKET PERFORMANCE: ANCILLARY MARKETS

### Monthly Regulation Price, Requirement and Supply 2023



#### Less volatile regulation prices and fewer shortfalls

In 2023, the annual average regulation price decreased to \$42.71/MWh from \$48.20/MWh in 2022. The highest monthly average price was \$63.10/MWh in March. The lowest monthly average of \$30.06/MWh was observed in January. Regulation prices were less volatile in 2023 than in the year before.

In 2022, the lowest monthly regulation price was \$27.44/MWh in September while the highest was \$85.04/MWh in July – a spread of \$57.60/MWh. In 2023, this spread narrowed to \$33.04/MWh. The standard deviation decreased to \$10.53/MWh in 2023 from \$17.96/MWh in 2022.

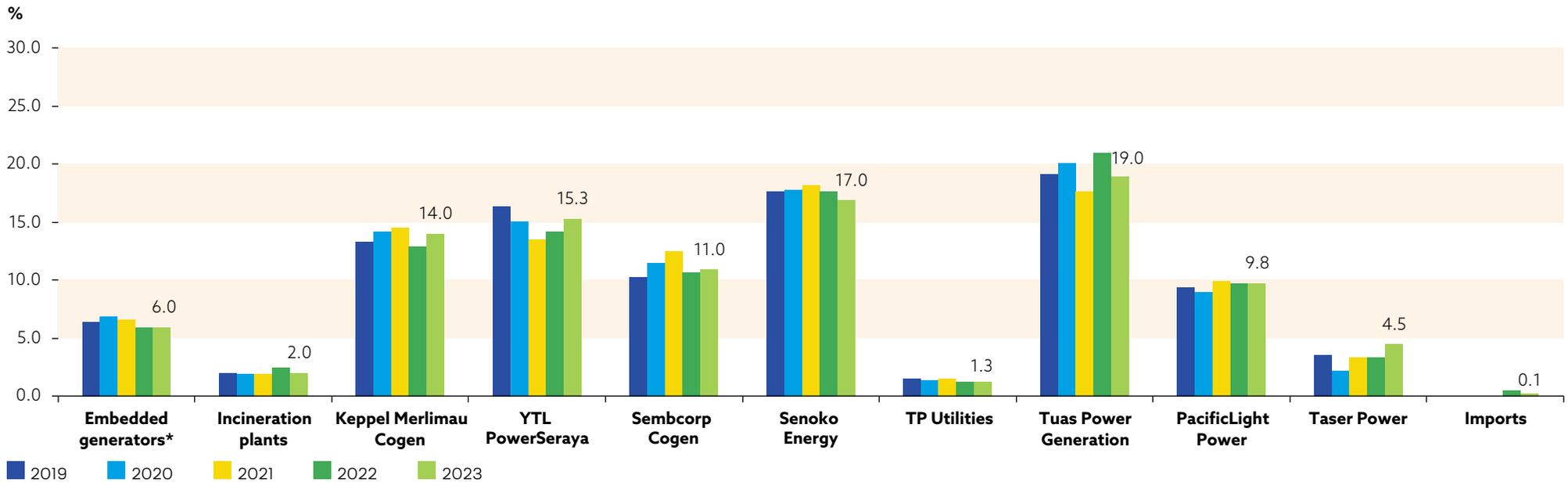
The annual regulation requirement was reduced to 117MW from 120MW as of 1 February 2023. The annual average regulation offers increased 2.5 percent to 201MW.

On a half-yearly basis, regulation offers ranged between 182MW and 200MW in the first half of the year, and between 202MW and 221MW in the second half. Correspondingly, the regulation offers below \$50.00/MWh averaged 129MW and 134MW in the first and second halves of the year respectively. The regulation price averaged lower in the second half of the year, due to more regulation offers in the cheaper price tranches.

The total number of periods with regulation shortfall plunged to 49 in 2023 from 112 in 2022. Notably, all periods of shortfalls occurred in the first half of the year. March registered the highest number of such periods – 19, which corresponded with the highest monthly average price of 2023 occurring that same month.

# MARKET PERFORMANCE: COMPETITION IN THE GENERATION AND RETAIL MARKETS

## Annual Market Share by Generation Company 2019–2023 (Based on Scheduled Generation)



\* Embedded generators exclude TP Utilities.

### Top three leading generation companies unchanged despite smaller market shares

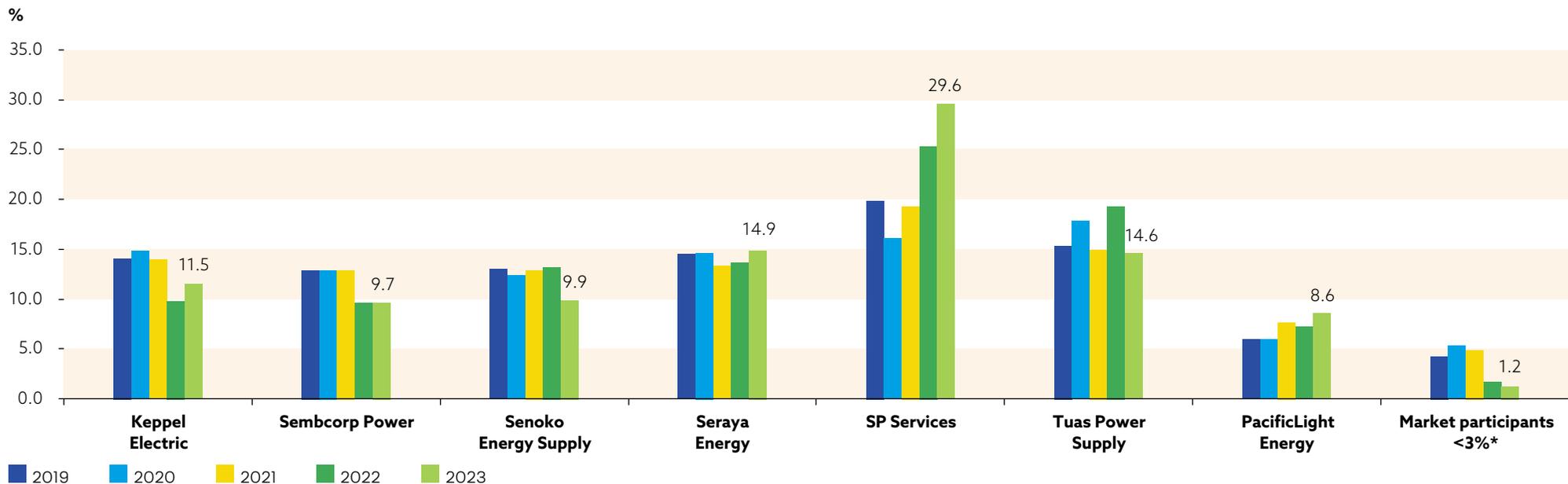
In 2023, Tuas Power Generation, Senoko Energy and YTL PowerSeraya remained the top three generation companies ranked by their annual market share. The combined market share of these three leading generation companies shrank 1.6 percentage points to 51.3 percent.

Among the generation companies which experienced a contraction in market share, Tuas Power Generation’s market share shrank the most, by 2.0 percentage points. This was followed by Senoko Energy’s market share shrinking 0.7 percentage point. Incineration plants’ and Imports’ market shares shrank by 0.5 percentage point and 0.4 percentage point respectively.

As for the remaining generation companies, Keppel Merlimau Cogen’s, YTL PowerSeraya’s and Taser Power’s market shares gained 1.1 percentage points each, while those of PacificLight Power, TP Utilities and EGs remained at 9.8 percent, 1.3 percent and 6.0 percent respectively.

## MARKET PERFORMANCE: COMPETITION IN THE GENERATION AND RETAIL MARKETS

### Annual Market Share of Market Support Services Licensee and Retailers 2019–2023 (Based on Withdrawal Energy Quantity)



\* Market participants <3% refers to Best Electricity Supply, Bioenergy, Cleantech Solar Singapore Assets, Diamond Electric, Engie South East Asia, Flo Energy Singapore, GreenCity Energy, Just Electric, Sunseap Energy and Union Power.

#### Market share of SP Services continues to grow

In the Open Electricity Market (OEM), the consumption of residential consumers who have switched from SP Services to retailers and who have selected the Load Profiling (LP) metering option (LP consumers) is included as part of the system residual load. This is wholly settled by SP Services in the NEMS. SP Services bilaterally settles the consumption of each retailer's aggregated LP consumers outside the NEMS.

To better reflect the market share of the retailers, the consumption of these LP consumers needs to be allocated back to their respective retailers. This allocation has been done and reflected in the retailers' market share figures since 2019.

In 2023, SP Services maintained the largest market share at 29.6 percent. This was a 4.2 percentage points gain from 2022 and was its largest market share since 2019. Among the larger retailers<sup>25</sup>, Keppel Electric overtook Senoko Energy Supply, joining Seraya Energy and Tuas Power Supply in the top three positions.

Keppel Electric's, Seraya Energy's, PacificLight Energy's and Sembcorp Power's market shares expanded by 1.6, 1.3, 1.3 and 0.1 percentage points respectively. Tuas Power Supply's market share shrank 4.7 percentage points, followed by Senoko Energy Supply, whose market share shrank 3.3 percentage points.

In the 'Market participants <3%' category, which comprises retailers that each hold a market share of under 3.0 percent, Best Electricity Supply and GreenCity Energy were deregistered in June<sup>26</sup>. The market share of this category of retailers shrank 0.5 percentage point to 1.2 percent.

<sup>25</sup> Excludes consumers who purchase from SP Services.

<sup>26</sup> Registration of Best Electricity Supply and GreenCity Energy expired by the end of trading date 30 June 2023.

## MARKET PERFORMANCE: SETTLEMENT, PRUDENTIAL MANAGEMENT, AUTOMATIC FINANCIAL PENALTY SCHEME AND MINIMUM STABLE LOAD COMPENSATION SCHEME

EMC is the financial clearing house for the wholesale market and settles the following transactions:

- energy;
- ancillary market products – two classes of reserve (primary and contingency) and regulation;
- bilateral and vesting contracts;
- uplift charges;
- financial adjustments;
- fee recovery of EMC and the PSO administration costs; and
- contracted ancillary services not provided through the ancillary market (black-start services).

The market is well secured. To cover the exposure of a debtor and the time required to manage a default, all retailers must provide on-going collateral to EMC. This credit support protects EMC and other MPs from payment defaults. EMC reviews the risk exposure of MPs daily.

### Margin Calls and Notices of Default – 1 January to 31 December 2023

A margin call is issued when a retailer's estimated net exposure reaches a value that is equivalent to or greater than 55.0 percent of its level of credit support for MPs, or 60.0 percent of its level of credit support for the MSSL. There was no margin call issued in 2023. A notice of default<sup>27</sup> is issued when an MP is unable to remit to the EMC settlement clearing account by the end of the business day following its payment due date. In 2023, EMC issued no default notice<sup>28</sup>.

### Automatic Financial Penalty Scheme (AFPS) and Minimum Stable Load (MSL) Compensation Scheme – 1 January to 31 December 2023

The Automatic Financial Penalty Scheme (AFPS) is a penalty scheme that was introduced in November 2015 and applied to all GRFs that deviate from their dispatch schedules by more than 10MW. The intent is to discourage the GRFs from non-compliance of dispatch instructions. The AFPS was subsequently extended to include all load registered facilities (LRFs) under the DR programme which was introduced in April 2016, and now applies to all LRFs with restricted energy bids that deviate from their dispatch schedules. In 2023, there were 208 periods when the AFPS kicked in, including 142 periods for deviating LRFs. The total penalty collected was \$1,146,444.37. The penalty collected was returned to the market via the monthly energy uplift charges.

The Minimum Stable Load (MSL) compensation scheme compensates participating GRFs when they are constrained for energy at their MSLs and their offer prices are higher than the marginal clearing price. It was implemented in November 2015 to enhance system security and create financial certainty for these facilities over the recovery of costs. In 2023, \$177,592.16 was paid out for a total of 17 periods under the MSL compensation scheme. The amount paid out was funded by the market via the monthly energy uplift charges.

<sup>27</sup> A notice of default is issued to a defaulting market participant up till the market participant is suspended.

<sup>28</sup> Default notices relating to settlement payments.

## MARKET PERFORMANCE: CONTRACTED ANCILLARY SERVICES

In addition to the co-optimised energy, reserve and regulation markets, EMC negotiates and enters into ancillary services contracts on behalf of the PSO, to ensure the reliable operation of Singapore's power system. If these services cannot be procured competitively due to a limited number of available suppliers, for example, their prices are regulated.

From 1 April 2023 to 31 March 2024, the only contracted ancillary service required was black-start capability.

Black-start services ensure that there is initial generation to supply electric power for system restoration following a complete blackout. Based on the PSO's operational requirements, EMC procured 88.848MW of black-start services at a cost of \$10.87 million for the period from 1 April 2023 to 31 March 2024. The capability was sourced from YTL PowerSeraya, Senoko Energy, Tuas Power Generation, and Keppel Merlimau Cogen.

### Contracted Ancillary Services – 1 April 2023 to 31 March 2024

Contract Period	Cost of Ancillary Services (including GST)	Total MW Contracted
1 April 2023 to 31 March 2024	\$10,866,952.88	88.848

## MARKET PERFORMANCE: MARKET FEES

The costs associated with the wholesale functions of the NEMS are recovered directly from the wholesale market through fixed fees as well as variable fees that are proportionate to the quantity of energy that the MPs trade.

### EMC Fees - 1 July 2023 to 30 June 2024

Market Participant (MP) Fee	\$10,000 per MP (annual)
MP Registration Fee	\$5,000 per registration (one-off)
RSA Hardware Token Fee	\$350 per token (once every three years from 6 <sup>th</sup> token onwards per MP) \$110 per token (replacement fee for lost or damaged token)
EMC Fee per MWh (\$/MWh)	0.3703

### PSO Fixed Fees - 1 July 2023 to 30 June 2024

MP Fee	\$3,500 per MP (annual)
MP Registration Fee	\$1,650 per legal entity registration (one-off)

### PSO Net Fees - 1 April 2023 to 31 March 2024

PSO Net Fees (\$'000)	32,409
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# ADDITIONAL INFORMATION

## ADDITIONAL INFORMATION: GLOSSARY

### ancillary services

The additional services needed to ensure the security and reliability of the power system. The ancillary services traded competitively on the wholesale market are regulation and the two classes of reserves (primary and contingency). The black-start ancillary service is contracted by Energy Market Company (EMC) on behalf of the Power System Operator (PSO) on an annual basis.

### battery energy storage system (BESS)

Battery energy storage system (BESS) is an electrochemical ESS where stored chemical energy can be converted to electrical energy when required.

### black-start ancillary service

A service to ensure that there is initial generation of power, without using power from the grid, so as to restore systems following a complete blackout.

### co-optimisation

The process used by the market clearing engine (MCE) to ensure that the most inexpensive mix of energy, reserves, and regulation is purchased from the market to meet electricity demand in each dispatch period.

### demand response (DR)

This enables contestable consumers to voluntarily reduce their electricity demand in response to market conditions, particularly during periods of high wholesale market prices or when system reliability is adversely affected.

### dispatch schedule

A schedule produced by the market clearing engine (MCE) every half-hour. It is the basis for the supply and consumption of energy, and the supply of reserve and regulation in the market.

### embedded generators (EG)

Generation units that generate electricity to their on-site load principally for self-consumption.

### event of default

The failure of a market participant (MP) to fulfil its payment obligations or other basic obligations under the market rules. An event of default, if not remedied, will trigger a suspension procedure on the defaulting MP. For a full list of events of default, please refer to the [Market Rules](#).

### intermittent generation sources (IGS)

Sources of energy whose output depends on environmental factors and weather conditions, such as solar and wind energy. While there are IGS facilities connected to the grid in Singapore, IGS are not scheduled for dispatch by the Power System Operator (PSO) in the wholesale market because the power output cannot be controlled or varied at will.

### interruptible load (IL)

The amount of electricity that a consumer makes available for interruption in the event of a system disturbance in exchange for reserve payment. The Power System Operator (PSO) controls the activation of interruptible loads.

### licensed capacity

Capacity of a facility licensed by the Energy Market Authority (EMA).

### LNG vesting price (LVP)

The price for the Liquefied Natural Gas (LNG) vesting quantity allocated.

### LNG vesting quantity (LVQ)

Under the Liquefied Natural Gas (LNG) Vesting Scheme from July 2013 to June 2023, a certain percentage of the total allocated vesting quantity is pegged to LNG. This is known as the LNG vesting quantity.

### market clearing engine (MCE)

The linear programme computer application used to calculate spot market quantities and prices.

### market participant (MP)

A person or entity which has been registered with Energy Market Company (EMC) as a market participant to trade in the wholesale electricity market.

### metered demand

The electricity consumption that is proxied by the withdrawal energy quantity (WEQ).

## ADDITIONAL INFORMATION: GLOSSARY

### **nodal pricing**

A market structure in which prices are calculated at specific locations, or nodes, in the power system to reflect the demand and supply characteristics of each location, taking into consideration transmission losses and congestion. Nodal pricing is also commonly referred to as locational marginal pricing. In the settlement reports, this is termed the market energy price.

### **open electricity market (OEM)**

An initiative by the Energy Market Authority (EMA) to enable all business consumers and households to buy electricity from a retailer of their choice at a price plan that best meets their needs, or remain on the regulated tariff rate.

### **reference uniform Singapore energy price (RUSEP)**

The uncapped counterfactual USEP when the Temporary Price Cap (TPC) is in effect. Similar to USEP, it is the weighted-average of the uncapped nodal prices at all off-take nodes.

### **registered capacity**

This denotes the capacity of a facility registered with the National Electricity Market of Singapore (NEMS). Registered capacity may differ from licensed capacity.

### **regulation**

Generation that is on standby to fine-tune or correct frequency variations or imbalances between demand and supply in the power system.

### **retail market**

The transactions made between retail companies and end consumers.

### **retailer of last resort (RoLR)**

The one or more retailers who will take responsibility for the customers of a retailer that is no longer able to, or has lost the right to, retail electricity to its customers.

### **supply cushion**

This measures the percentage of total supply available that offered into the market after matching off demand.

### **uniform Singapore energy price (USEP)**

The weighted-average of the nodal prices at all off-take nodes.

### **vesting contract**

An instrument issued by the Energy Market Authority (EMA) to hedge the price of energy to be procured from the Singapore Wholesale Electricity Market (SWEM) for supply to non-contestable consumers. The vesting contracts are structured as bilateral two-way contract-for-differences between the Market Support Services Licensee (MSSL) and a holder, which is typically a commercial generation company. A vesting contract requires these generators to sell a specified quantity of electricity at a specified price.

### **vesting contract hedge price (VCHP)**

This is the price used by Energy Market Company (EMC) to settle the vesting quantity between the Market Support Services Licensee (MSSL) and the generation companies.

### **withdrawal energy quantity (WEQ)**

This is measured in megawatt hour and refers to the amount of electricity withdrawn by load facilities. It is provided by the Market Support Services Licensee (MSSL), SP Services.

### **wholesale market**

The transactions made between generation companies and retail companies.

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