
nems
20TH
ANNIVERSARY
MARKET
REPORT
2022

CONTENTS

2022 AT A GLANCE

Total registered capacity of generators
▲ 3.2%
12,563MW

11 new facilities were added to the market

1 new generator and
4 new wholesale market traders joined the market

Number of periods with Demand Response curtailment
▲ 157.4%
883 periods

Demand Response payment
▲ 60.2%
$21.30 million

Electricity consumption
▲ 1.7%
54.5TWh

Generation supply
▼ 7.1%
7,375MW

Annual value of products traded
▲ 50.0%
$17.83 billion

Uniform Singapore Energy Price (USEP)
▲ 48.6%
$291.81/MWh

Combined market share of top 3 generation companies grew to
52.9%

Market share of SP Services grew to
25.4%

LETTER FROM THE CHAIRMAN

Dear Industry Members

Thank you for the remarkable support for the National Electricity Market of Singapore (NEMS) despite the challenging market conditions in 2022. The ongoing conflict in Europe has not only strained global supply chains and elevated fuel prices but also dampened economic recoveries emerging from the Covid-19 pandemic.

On a more positive note, we celebrated the lifting of almost all Covid-19 restrictions in Singapore and welcomed all employees back to the office. Singapore's GDP also grew by 3.6 percent, with electricity demand increasing by 1.7 percent to an all-time high of 54.5 terawatt hour.

2022 in Review

Following 2021's record level, the annual value of products traded in the wholesale market recorded another peak, surpassing $17.8 billion, a 50-percent increase. This was due to higher electricity demand and elevated electricity prices in the Singapore Wholesale Electricity Market.

With generation supply falling to 7,375MW and the increase in electricity demand, we observed the tightening of supply cushion to a historic low. As a result, the average Uniform Singapore Energy Price (USEP) rose significantly to $291.81 per megawatt hour (MWh) – the highest level since the market started in 2003. The highest monthly average USEP was observed in January at $480.21/MWh with the highest daily USEP of $1,054.62/MWh recorded on 30 January.

Despite the higher USEP, the market saw relatively lower price volatility in 2022 as compared to the previous year. The measures introduced by the Energy Market Authority (EMA) to manage the power system and market amidst the global energy crisis, together with existing programmes such as the Demand Response (DR) programme, have helped to stabilise the USEP.

I am also delighted to share that we saw a record number of periods with DR curtailment, jumping from 343 in 2021 to 883 in 2022. The total curtailed load of 16,008MW also increased by more than 94.2 percent when compared to 2021. Nonetheless, the number of DR curtailment is still relatively low, at only 14% of DR utilisation. An active usage of the DR programme is important as it will increase the agility of the market to respond to situations when supply tightens. In the next two years, EMC will work with the industry to enhance and trial the Demand Management Sandbox to raise consumers' awareness of the DR programme and encourage more DR participation in the market.

2022 also saw important milestones in Singapore's energy transition. In June, Keppel Electric started importing 100MW of hydropower renewable energy from Laos. The project marked the first renewable energy import into Singapore and kick-started Singapore's plan to import up to 4 gigawatt of electricity by 2035.

In November, Sembcorp Cogen commissioned Southeast Asia's largest battery energy storage system (BESS) on Jurong Island. At a capacity of 285MWh, the BESS will support solar energy deployment, enhance grid reliability and energy supply security in Singapore.

LETTER FROM THE CHAIRMAN

The NEMS 20th Anniversary

We will be celebrating the 20th Anniversary of the NEMS in 2023. The NEMS opened for trading on 1 January 2003, placing Singapore at the forefront of a global movement to liberalise the electricity industry.

Over the last 20 years, the NEMS witnessed several key milestones, such as the commencement of the first interruptible load provider and the spurring of market competition with the privatisation of generation companies in 2006 and 2008 respectively. We also saw the launch of the DR programme in 2016 and the Open Electricity Market in 2018. There was also significant growth of solar energy generation in the last few years and more recently, the first renewable energy imports from Laos.

While recent price spikes and exits of retailers have raised some concerns about the effectiveness of the market, the development of the NEMS over the last 20 years has been tremendous and is a testament to how the market has evolved to stay relevant, drive economic growth and encourage market competition. The success of the NEMS would not have been possible without the immense support from EMC colleagues, the Energy Market Authority (EMA) and our industry partners.

Forging a Resilient Energy Market

The energy landscape has changed significantly over the last 18 months. Disruptions of global gas supply, tightening of generation supply and the exit of six electricity retailers in 2021 had highlighted the importance of a sustainable and resilient energy market.

EMC is committed to work with the EMA to consult widely and introduce safeguards to strengthen the market in three key areas – power generation, gas supply and electricity retail markets. These safeguards are intended to ensure that the market continues to function well.

Another exciting update was the launch of Singapore's National Hydrogen Strategy in October. The strategy provides a roadmap of how hydrogen can support Singapore's international climate commitment to achieve net zero emissions by 2050. I look forward to the completion of the nation's first hydrogen-ready power plant in 2026.

I am upbeat that the market is in good stead to learn and grow from the challenges in 2022. Together with the regulators and our industry partners, I am confident that the energy market will continue to be competitive, resilient, and be the bedrock of Singapore's growing economy.

Agnes Koh
Chairman
Energy Market Company

MARKET OVERVIEW

MARKET HISTORY

The National Electricity Market of Singapore (NEMS) opened in January 2003 – 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 First solar facility registered
2018	The 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 Southeast Asia's largest battery energy storage system (BESS) on Jurong Island commenced operation

INDUSTRY STRUCTURE

Participants and Service Providers in the NEMS

Generators

ExxonMobil Asia Pacific
Keppel Merlimau Cogen
Keppel Seghers Tuas Waste-to-Energy Plant (Tuas DBOO Trust)
National Environment Agency
PacificLight Power
Sembcorp Cogen
Sembcorp Floating Solar Singapore
Sembcorp Solar Singapore
Senoko Energy
Senoko Waste-to-Energy
Shell Eastern Petroleum
Singapore Refining Company
Taser Power*
TP Utilities
Tuas Power Generation
TuasOne
Tuaspring*
YTL PowerSeraya

Wholesale Market Traders

Air Liquide Singapore
CGNPC Solar-Biofuel Power (Singapore)/ JE Green Solutions
CrystalClear Environmental*
Enel X Singapore
Green Power Asia
LYS Genco Beta
MSD International GmbH (Singapore Branch)
PSA Corporation*
Public Utilities Board
Singapore District Cooling
Singapore LNG Corporation
SolarLand Alpha Assets*
Sunseap Energy Ventures
Sunseap Leasing
Sunseap Leasing Beta
Sunseap VPower
Terrenus Energy*
Terrenus Energy SL1X*
Terrenus Energy SL2

Retailers

Best Electricity Supply
Bioenergy
Cleantech Solar Singapore Assets
Diamond Electric
Flo Energy Singapore
GreenCity Energy
Hyflux Energy*
Just Electric
Keppel Electric
Ohm Energy*
PacificLight Energy
Sembcorp Power
Senoko Energy Supply
Seraya Energy
Sunseap Energy
Tuas Power 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 2022:*
- *SolarLand Alpha Assets, PSA Corporation, Taser Power, CrystalClear Environmental and Terrenus Energy SL1X joined the market in February, March, June, October and October respectively.*
- *Hyflux Energy, Tuaspring, Terrenus Energy and Ohm Energy withdrew from the market in April, June, November and November respectively.*

INDUSTRY STRUCTURE

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

Market Participant Changes

In 2022, the NEMS welcomed one new generator (Taser Power) and four new wholesale market traders (SolarLand Alpha Assets, PSA Corporation, CrystalClear Environmental and Terrenus Energy SL1X). This brought the total number of market participants (MPs) in the NEMS to 50 at the end of 2022, comprising 17 generators, 18 wholesale market traders and 15 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 the 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 security of electricity supply 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 system. The PSO also oversees the real-time operation of the natural gas transmission system.

Regulator — Energy Market Authority

The 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 FEATURES

The NEMS has a number of 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, and 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;
- available dispatchable load 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.

Energy, Reserve and Regulation Products

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

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 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 116 injection nodes, and the prices at up to 877 withdrawal or off-take nodes[1] 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.

1 *Numbers of injection and withdrawal nodes are as of 31 December 2022.*

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 calculated based on the estimated falls in the USEP across all 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.


MARKET
GOVERNANCE

OVERVIEW

Governing Documents and Institutions

The Energy Market Authority (EMA) was established under the Energy Market Authority of Singapore Act 2001. The EMA 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 day-to-day functioning of the National Electricity Market of Singapore (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 Energy Market Company (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 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. Each 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. The MSCP is appointed by the EMC Board and 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, before submitting a report 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 submits the quarterly MSCP Market Watch, which includes its monitoring, cataloguing and evaluation activities and analyses, to the MSCP. The MSCP provides a summary of investigative and monitoring activities to the EMC in the MSCP Annual Report, which has been published together with the NEMS Market Report 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 called the Dispute Resolution and Compensation Panel. The MAU assists the DRC in facilitating dispute resolution in the NEMS.

LETTER FROM THE CHAIR, RULES CHANGE PANEL

Dear Industry Members

The Rules Change Panel (RCP) plays a crucial role in guiding the continuous development of the Singapore Electricity Market Rules, to ensure they stay relevant in Singapore's wholesale electricity market. This role becomes increasingly important as Singapore undergoes an energy transition towards a more resilient and sustainable future.

Solar energy is one of Singapore's most promising renewable energy sources. With Singapore on track to achieve its solar deployment target of at least 2GWp by 2030 under the Singapore Green Plan, it is timely to enhance the market clearing algorithm to incorporate solar generation's contribution. With the advancement of technology, the Power System Operator (PSO) can accurately forecast solar generation with dynamic weather information.

The RCP supported the rule change to enable the market systems to dynamically capture solar generation forecasts provided by the PSO, thereby achieving greater accuracy in demand forecasts. This, in turn, generates more accurate price signals and dispatch schedules for dispatchable resources, thereby helping the PSO to better balance generation and consumption of electricity in real time.

When solar generation makes a more significant contribution to the generation mix, the incorporation of the solar generation forecasts would correspondingly provide more insight into the true supply condition. Availability of such data will also further enhance transparency in the market.

While Singapore is committed to achieving net zero emissions by 2050, the realisation paths of low-carbon energy alternatives such as green imports and hydrogen are not yet clear at this stage. The power system will, in the meantime, continue to heavily rely on gas-fired generation resources to meet the demand.

Since the beginning of 2022, the market has seen volatile prices arising from the global energy crunch. To stabilise the market, the Energy Market Authority (EMA) introduced emergency measures to help the market to tide through the energy crunch. The RCP promptly passed a rule change to exempt generators that have been directed by the PSO to perform fuel changeover under such emergency measures from automatic financial penalty for deviating from dispatch instructions.

The Panel examined and debated over various methods to provide reasonable remuneration to generators that are affected by such emergency measures. The solution seeks to ensure they can continue to deliver and keep the power system stable and reliable, while not distorting the price signals or imposing an undue burden on consumers. While the study is ongoing, I trust the findings would provide much-needed clarity on how the availability of generators should be valued during times of emergency.

I am proud of the constructive debates and deliberations put up by the Panel when evaluating rule changes, and encouraged that they have contributed to a better Singapore electricity market. I would like to express my deepest gratitude to my fellow Panel members for their dedication, to the Energy Market Company (EMC) Board and the EMA for considering and reviewing rule changes, and to all market participants who actively contributed to the rule change process with their ideas and inputs.

In 2023, the NEMS will celebrate 20 years of success, introducing and pushing for efficiencies across the electricity industry. Singapore has also committed to reaching net zero emissions by 2050. The Market Rules going forward must therefore evolve to enable and encourage the adoption of carbon-neutral or low-carbon alternatives for generation, and support greater demand-side participation. The RCP will be hugely influential in this process. With my panel colleagues, I am confident and look forward to contributing to this important journey.

Toh Seong Wah
Chair
Rules Change Panel

MARKET EVOLUTION

Rule Changes Supported by the RCP

As part of the Rule Change Panel's (RCP) continual effort to facilitate development of the wholesale electricity market, the following rule changes were discussed and approved.

Incorporation of Solar Generation Forecasts in the Market Clearing Engine

With Singapore scaling up solar deployment across the island, becoming the key renewable energy source, the market clearing engine will need better visibility of non-dispatchable solar generation to determine the amount of dispatchable generation resources required to meet total load.

A rule change was proposed for the Power System Operator (PSO) to provide EMC with half-hourly solar generation forecasts.

The PSO has planned to upgrade its Energy Management System (EMS) by 2023 to incorporate solar forecast capability. Once completed, the PSO will be able to provide solar generation forecasts to EMC for each dispatch period. EMC will then be able to factor solar generation into the market clearing process, thereby producing more accurate schedules for dispatchable resources.

This rule change proposal was supported by the RCP and approved by the EMA on 14 April 2022. It will take effect in 2023 when the EMS upgrade is completed.

Exemption from the Automatic Financial Penalty Scheme during Fuel Changeover as Directed by the PSO

The Automatic Financial Penalty Scheme (AFPS) was established to incentivise compliance by Generation Registered Facilities (GRFs) with their dispatch schedules. There are, however, several permitted exemptions.

An EMA-directed rule change introduced in early 2022 established that the PSO may direct GRFs to use a specified fuel (natural gas or diesel) for its generation. When performing a fuel changeover, a GRF may need to de-load to a range when a fuel changeover can be done. The GRF's effective maximum capacity may also change when it switches to a different fuel. In this case, a GRF undergoing a fuel changeover may not be able to avoid deviating from its dispatch schedule.

Considering that the fuel changeover is carried out in compliance with the PSO's directions, and deviation from dispatch schedules is out of the genco's control during fuel changeovers, a rule change was proposed to exempt such GRFs from the AFPS.

This rule change proposal was supported by the RCP and approved by the EMA. It took effect on 14 September 2022.

Other Rule Changes Considered by the RCP

Clarification of Failure to Synchronise for Gate Closure Exemptions

Currently, a GRF that has experienced a forced outage or fails to synchronise to the grid is allowed to revise its offer within the gate closure period for the three consecutive periods immediately after the forced outage or failure to synchronise.

A rule change proposal was received from the industry recommending that when a technical fault has caused a facility's failure to synchronise, the timestamp for "failure to synchronise" should be assessed based on the timestamp of the "determination" that the technical fault led to the facility's inability to synchronise, as opposed to the timestamp being the trigger of the technical fault. The argument was that the time spent troubleshooting a fault can be significant and should be factored in.

EMC reviewed the proposal and clarified that, in the event that a facility cancels its synchronisation due to unanticipated technical faults, it shall not be deemed a "failure to synchronise" for the purposes of applying gate closure exemptions. Nevertheless, if the facility can demonstrate to the MSCP's satisfaction that the unanticipated technical faults constitute a "forced outage", then gate closure exemptions applicable to a "forced outage" shall apply for the three consecutive dispatch periods immediately following the incident.

EMC has also reviewed the proposal to define the timestamp of a facility's "failure to synchronise" as "the timestamp of the determination that the technical faults triggered led to the facility's inability to synchronise". EMC assessed that it potentially compromises system security and disincentivises facilities to promptly revise their offers to reflect its actual reduced capability. Therefore, EMC recommended that no rule change is required with respect to the proposed re-definition of the term, "failure to synchronise".

The RCP unanimously supported EMC's recommendation.

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 NEMS when required.

The DRCP members are:

Mediation Panel

1. Daniel John
2. Danny McFadden
3. Engelin Teh, Senior Counsel
4. Geoff Sharp
5. Associate Professor Joel Lee
6. Associate Professor 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 Jeyaretnam, Senior Counsel
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. Best Electricity Supply – Terence Neo
3. Bioenergy – David Leong
4. Cleantech Solar Singapore Assets – Andre Nobre
5. Diamond Electric – Olivier Veteau
6. Enel X Singapore – Carl Hutchinson
7. Energy Market Company – Dominic Tan
8. ExxonMobil Asia Pacific – Lim Li Fang
9. ExxonMobil Asia Pacific – Ma Xiu Yan
10. Flo Energy Singapore – Matthijs Guichelaar
11. GreenCity Energy – Chilton Loh
12. Green Power Asia – Daniel Ma
13. JE Green Solutions – Chin Cherk Min
14. JE Green Solutions – Tan Kuen Jong
15. Just Electric – Wittman Wah
16. Keppel Electric – Joelyn Wong
17. Keppel Electric – Tay Hock Hai

LETTER FROM THE DISPUTE RESOLUTION COUNSELLOR

18. Keppel Merlimau Cogen – Jeremy Lim
19. Keppel Merlimau Cogen – Sean Chan
20. LYS Genco Beta – Jonathan Chong
21. MSD International GmbH (Singapore Branch) – Zhou Mingjun
22. National Environment Agency – Teresa Tan
23. National Environment Agency – Yap Hwee Tat
24. PacificLight Energy – Ng Zi Kang
25. PacificLight Power – Yang Jia Xin
26. Power System Operator – Loh Poh Soon
27. Power System Operator – Oh Chai Choo
28. Public Utilities Board – Lee Si Jia
29. Sembcorp Cogen – Agnes Low
30. Sembcorp Cogen – Andy Lim
31. Sembcorp Floating Solar Singapore – Fendy Nursalim
32. Sembcorp Floating Solar Singapore – Kenny Kee
33. Sembcorp Power – Serina Wong
34. Sembcorp Power – Winson Kor
35. Sembcorp Solar Singapore – Fendy Nursalim
36. Sembcorp Solar Singapore – Kenny Kee
37. Senoko Energy – Poo Siok Yin
38. Senoko Energy Supply – Michelle Lim
39. Senoko Waste-to-Energy – Clifton Tan
40. Senoko Waste-to-Energy – Lee Song Koi
41. Seraya Energy – Alex Liam
42. Seraya Energy – Sarah Sum
43. Shell Eastern Petroleum – Benny Leng
44. Shell Eastern Petroleum – Koh Sian Kim
45. Shell Eastern Petroleum – Teo Woon Kai
46. Singapore District Cooling – Dennis Chong
47. Singapore District Cooling – John Tan
48. Singapore LNG Corporation – Jasmine Pang
49. Singapore LNG Corporation – Vincent Lam
50. Singapore Refining Company – Balasubramaniam Sundararaj Mohanakkannan
51. Singapore Refining Company – Ho Weng Foo
52. SP PowerAssets – Chan Hung Kwan
53. SP Services – Ho Yin Shan
54. SP Services – Rachel Su
55. Sunseap Energy – Laurence Kwan
56. Sunseap Leasing – Laurence Kwan
57. Sunseap Leasing Beta – Laurence Kwan
58. Sunseap VPower – Laurence Kwan
59. Taser Power – Albert Siah
60. Taser Power – Kenrick Tan
61. Terrenus Energy SLX1 – Charles Wong
62. Terrenus Energy SLX1 – David Chan
63. Terrenus Energy SL2 – Charles Wong
64. Terrenus Energy SL2 – David Chan
65. TP Utilities – Daniel Lee
66. Tuas DBOO Trust – Chen Zhixuan
67. Tuas DBOO Trust – Victor Fong
68. Tuas Power Generation – Priscilla Chua
69. Tuas Power Supply – Jazz Feng
70. Tuas Power Supply – Kessler Wong
71. TuasOne – Kwanwei Sim
72. TuasOne – Mitsuru Tada
73. Union Power – Ellen Teo
74. Union Power – Eric Lim
75. YTL PowerSeraya – Albert Siah
76. YTL PowerSeraya – Kenrick Tan

Dispute Resolution Training

As part of my responsibilities, I provide training in dispute resolution for the DMS contacts.

On 3 March 2022, I conducted a virtual briefing and refresher on the NEMS' dispute resolution process for the DMS contacts. The virtual workshop was organised and supported by EMC's Market Assessment Unit.

Conclusion

I am happy to report that in 2022, no disputes were filed with this office. Even though a market participant raised an enquiry on a potential dispute, which was discussed and clarified with the party, no further action was taken, and we hope that the issue has been resolved to both parties' satisfaction. I thank the DRCP members and DMS contacts for their contributions and look forward to continuing to support the dispute resolution needs of all NEMS market entities in the coming year.

George Lim

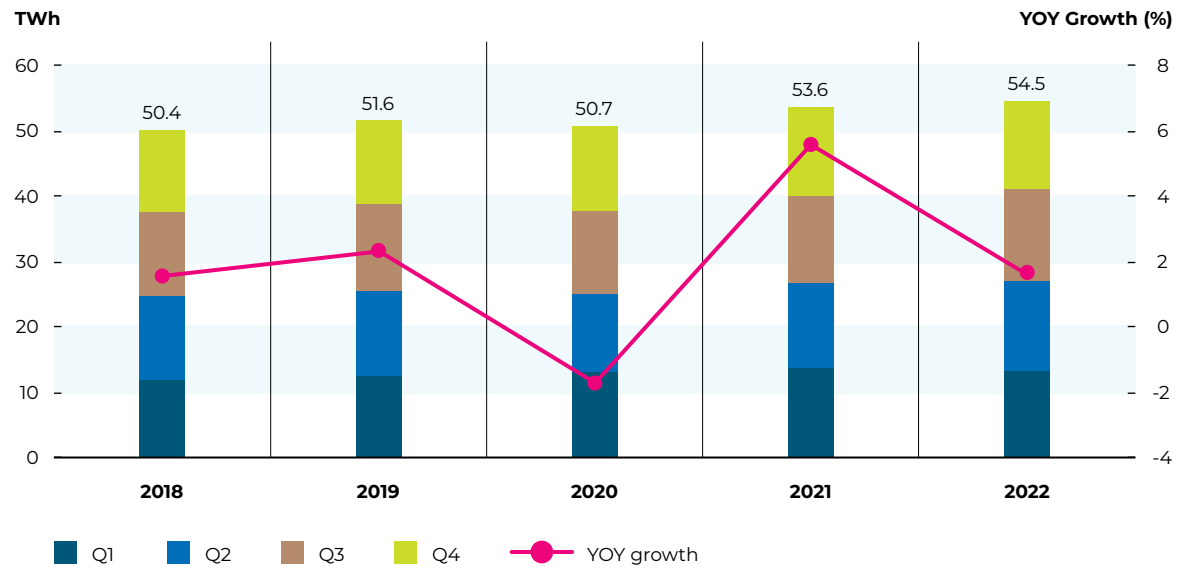
Senior Counsel

Dispute Resolution Counsellor


MARKET
PERFORMANCE

OVERVIEW OF THE YEAR

Annual Electricity Consumption 2018–2022



Electricity consumption growth moderated in 2022

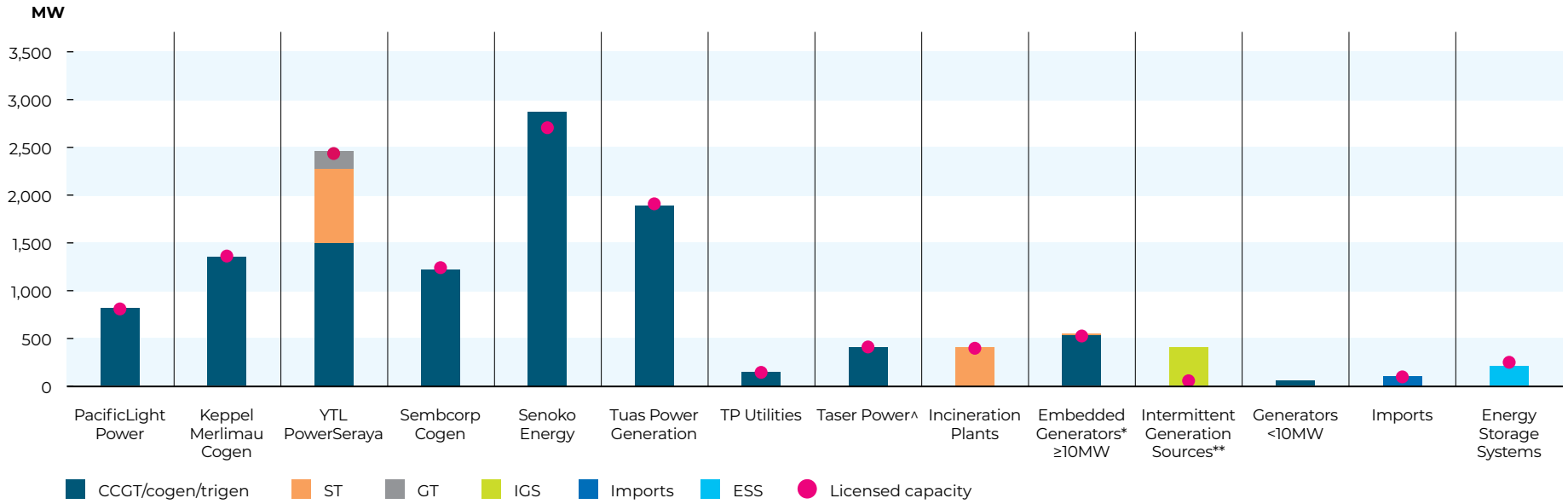
Electricity purchased by market participants (MP) is settled using electricity consumption data provided by the Market Support Services Licensee (MSSL).

In line with the 3.6 percent[2] growth in Singapore's economy, which was lower than that in 2021, the annual growth in electricity consumption was 1.7 percent, slower than 2021's. Total electricity consumption stood at 54.5 terawatt hour (TWh), surpassing the peak registered last year.

Compared to the same quarters in 2021, electricity consumption grew between 0.7 and 4.7 percent year-on-year (YOY) in the first three quarters in 2022, then contracted 1.5 percent YOY in the fourth quarter. Notably, the electricity consumption levels in the first three quarters were the highest since the market started. The largest increase of 4.7 percent was recorded in the first quarter, compared to the same quarter in 2021 when the economy had just started reopening following the Covid-19 Phase 2 heightened alert status. The decline of 1.5 percent in the fourth quarter correlated with lower temperatures and contraction in the manufacturing sector activity in that quarter.

2 *"MTI Maintains 2023 GDP Growth Forecast at "0.5 to 2.5 Per Cent"": Ministry of Trade and Industry, Singapore, 13 February 2023.*

Generation Capacity as at 31 December 2022: Registered Versus Licensed



* Embedded generators exclude TP Utilities.
** Intermittent generation sources include NEIGFs.
^ Formerly Tuaspring.
Licensed capacity for facilities <10MW excluded as the information is not publicly available.

Licensed and registered capacities increase in 2022

Total licensed capacity[3] in the National Electricity Market of Singapore (NEMS) with generation capacity larger than or equal to 10 megawatts (MW) increased by 300MW to 12,045MW[4] in 2022. The increase came from Sembcorp Cogen's battery energy storage systems (BESS) of 200MW licensed capacity and Keppel Electric's import facility of 100MW licensed capacity.

Total registered capacity[5] of generation facilities increased 3.2 percent to 12,563MW[6] in 2022. This was attributed to the addition of one import facility, three ESS facilities and three generation registered facilities, as well as the capacity revision of eight generation registered facilities in the NEMS. The registered capacity of IGS including NEIGFs expanded 26.9 percent to 396MW, while that of ESS grew from 5MW to 208MW.

Compared to 2021, the proportion of CCGT/cogen/trigen registered capacity to total registered capacity declined by 2.6 percentage points to 83.8 percent. The proportion of ESS registered capacity to total registered capacity increased from 0.04 percent to 1.7 percent, while that of IGS including NEIGFs increased from 2.6 percent to 3.2 percent. Import registered capacity constituted 0.8 percent of total registered capacity.

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

3 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.
4 Licensed capacity in 2022 included generation facilities ≥10MW and an import. The first import entered the market in 2022.
5 In 2021, registered capacity including energy storage systems was 12,170MW. In 2022, registered capacity included energy storage systems and imports.
6 In 2021, there was a downward revision of Senoko Energy's CCGT/cogen/trigen unit capacity, which could not be reflected in the total registered capacity.

OVERVIEW OF THE YEAR

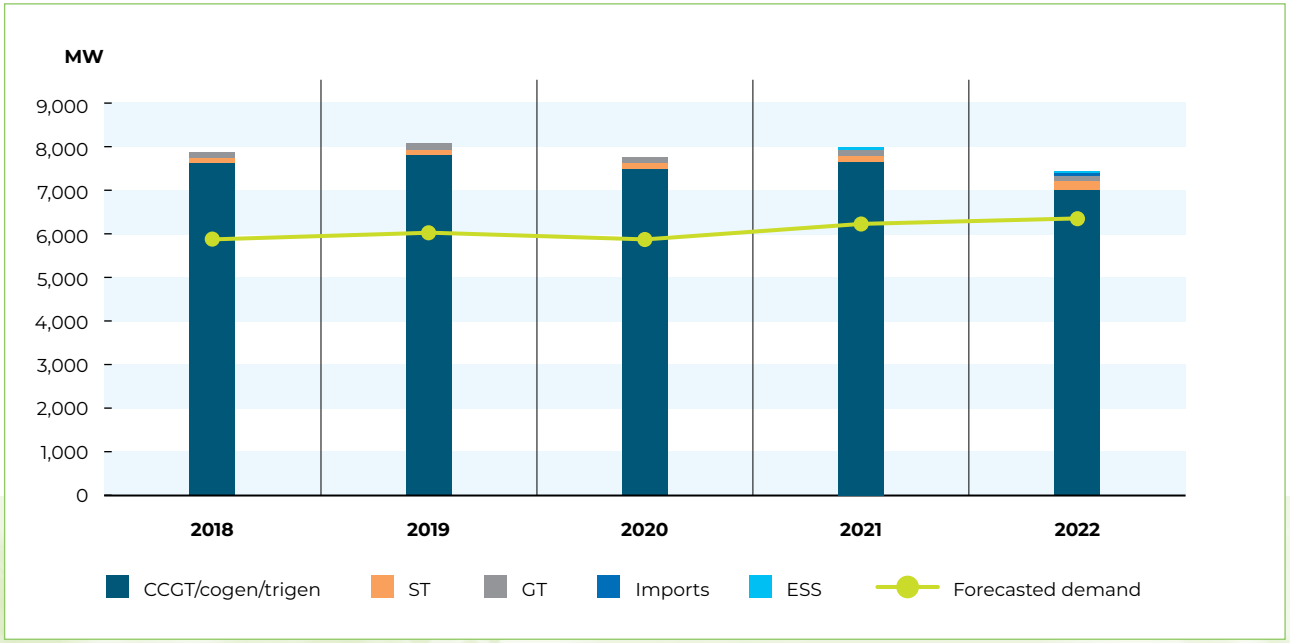
Annual generation supply plummets in 2022

In 2022, the annual generation supply slumped 7.1 percent[7] to 7,375MW[8], which was the lowest level since 2014. The sharp decline came on the back of the proportion of periods with upstream gas curtailment surging from 40.3 percent in 2021 to 80.7 percent in 2022.

In line with the lower overall generation supply, CCGT/cogen/trigen supply plunged 8.1 percent to 7,032MW, which was the lowest level since 2014. The CCGT/cogen/trigen supply was 11.6 percent above forecasted demand, which was the narrowest margin in the past 11 years. The margin narrowed due to lower CCGT/cogen/trigen supply and higher demand.

ST supply expanded 31.4 percent to 169MW, while GT supply fell 3.6 percent to 149MW. ESS supply[9] increased from 2MW in 2021 to 3MW in 2022. Import supply began in June 2022, averaging at 21MW for the year.

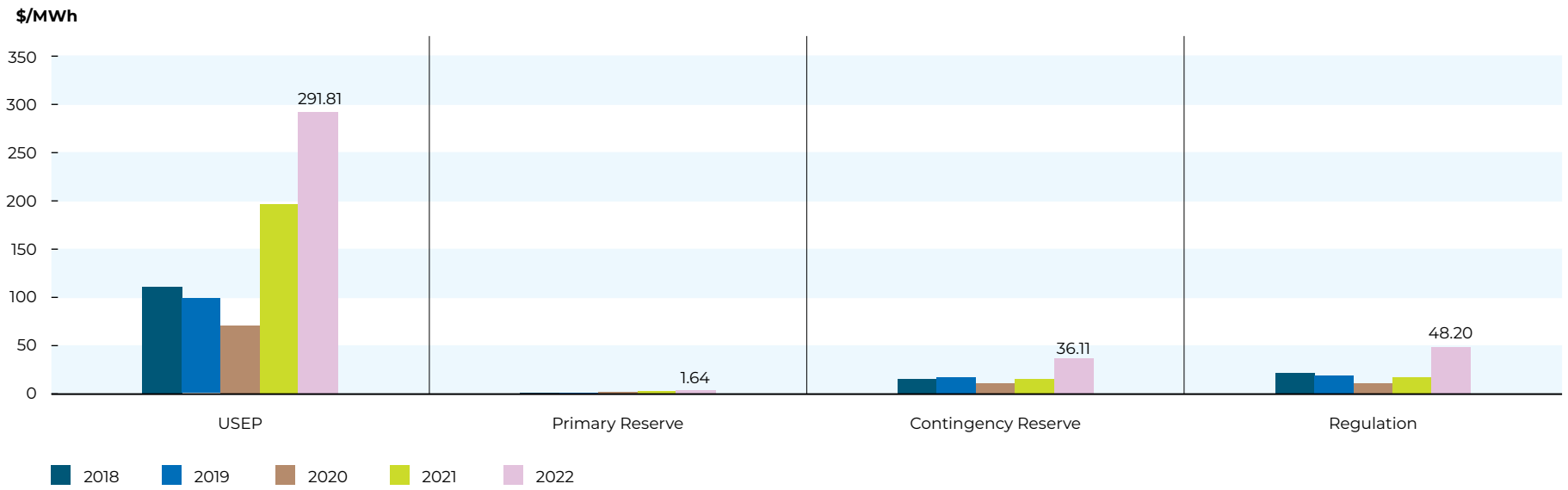
Annual Generation Supply by Plant Type 2018–2022



7 *In 2021, total supply including energy storage systems was 7,938MW.*
8 *In 2022, total supply included energy storage systems and imports. The first import entered the market in June 2022.*
9 *Based on modelled offer capacity.*

OVERVIEW OF THE YEAR

Annual USEP and Ancillary Prices 2018–2022



Prices of all products increase in 2022

The average Uniform Singapore Energy Price (USEP) surged by 48.6 percent from $196.33 per megawatt hour (MWh) in 2021 to $291.81/MWh in 2022, which was the highest level since the market started. This was the result of the supply cushion tightening to a historic low, which was brought on by the total supply contracting to a nine-year low amidst higher forecasted demand.

The primary reserve price increased from $1.13/MWh in 2021 to $1.64/MWh in 2022. The increase came as a result of the offers contracting more than the drop in requirement.

The contingency reserve price more than doubled from $14.43/MWh in 2021 to $36.11/MWh in 2022. This was attributed to the number of periods with contingency reserve shortfall hitting a record high, outweighing the effect of lower requirement from July onwards when the Risk Adjustment Factor (RAF) was lowered from 1.5 to 1.0 due to increased intertie connection capacity.

The regulation price nearly tripled from $16.45/MWh in 2021 to $48.20/MWh in 2022, as the number of periods with regulation shortfall spiked to a record high. The requirement was also revised upward from 114MW to 120MW, with effect from 1 February 2022.

OVERVIEW OF THE YEAR

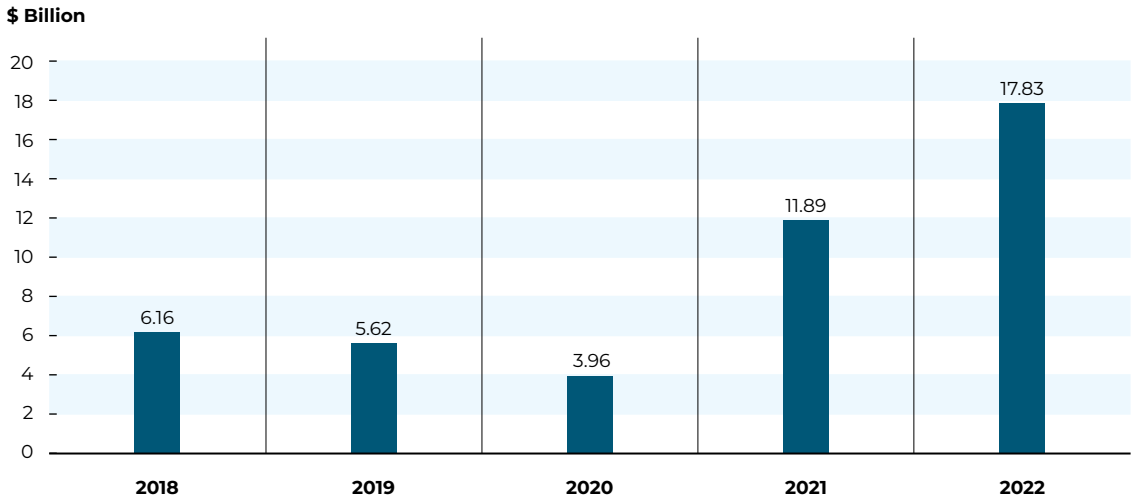
Annual value of products traded continues rising

The value of products traded shows the transacted value for all products traded in the NEMS: 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 on a daily basis.

In 2022, the annual value of products traded increased by 50.0 percent to $17.83 billion, surpassing $10 billion for the second consecutive year. This was attributed to higher market prices and electricity consumption.

The energy market accounted for 98.7 percent of all products traded, while the reserve and regulation markets accounted for 1.0 and 0.3 percent respectively.

Annual Value of Products Traded 2018–2022



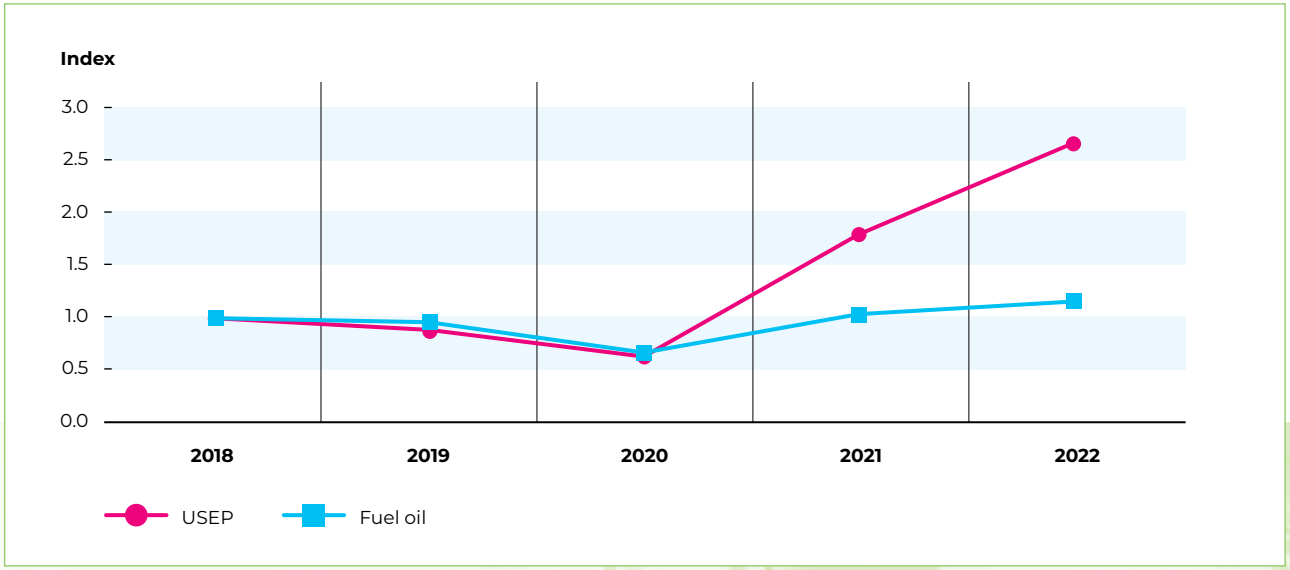
OVERVIEW OF THE YEAR

USEP index rises faster than fuel oil index[10]

In 2022, the USEP index[11] increased to 2.65, while the fuel oil price index increased to 1.15. Both indices moved in tandem, with the USEP index leading the gains for the second consecutive year.

Both indices rose in parallel, in line with the tighter fuel supply. The rise in the USEP index outpaced that of the fuel oil price index, widening the gap between these two indices.

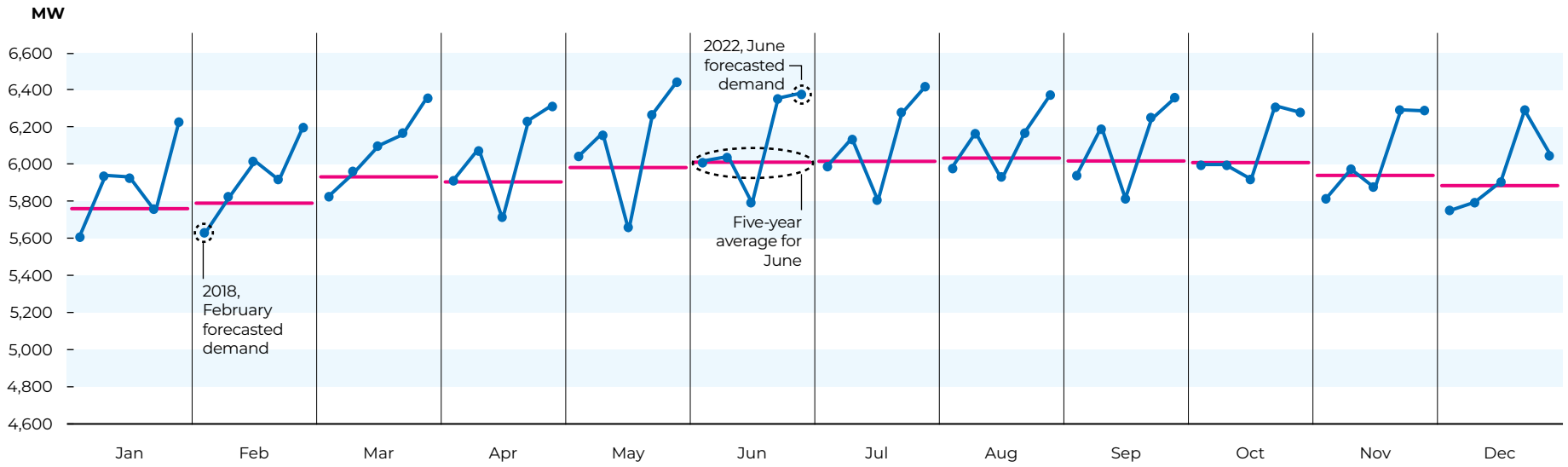
Annual USEP and Fuel Oil Price Movements 2018–2022



10 Used as a proxy for fuel oil price.
11 The USEP index is computed using 2018 as the index base. Therefore, the USEP index in 2018 is 1, while the USEP index in 2022 is 2.65 (computed using the 2022 USEP of $291.81/MWh divided by the 2018 USEP of $110.29/MWh).

ENERGY DEMAND

Monthly Forecasted Demand 2018–2022



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.

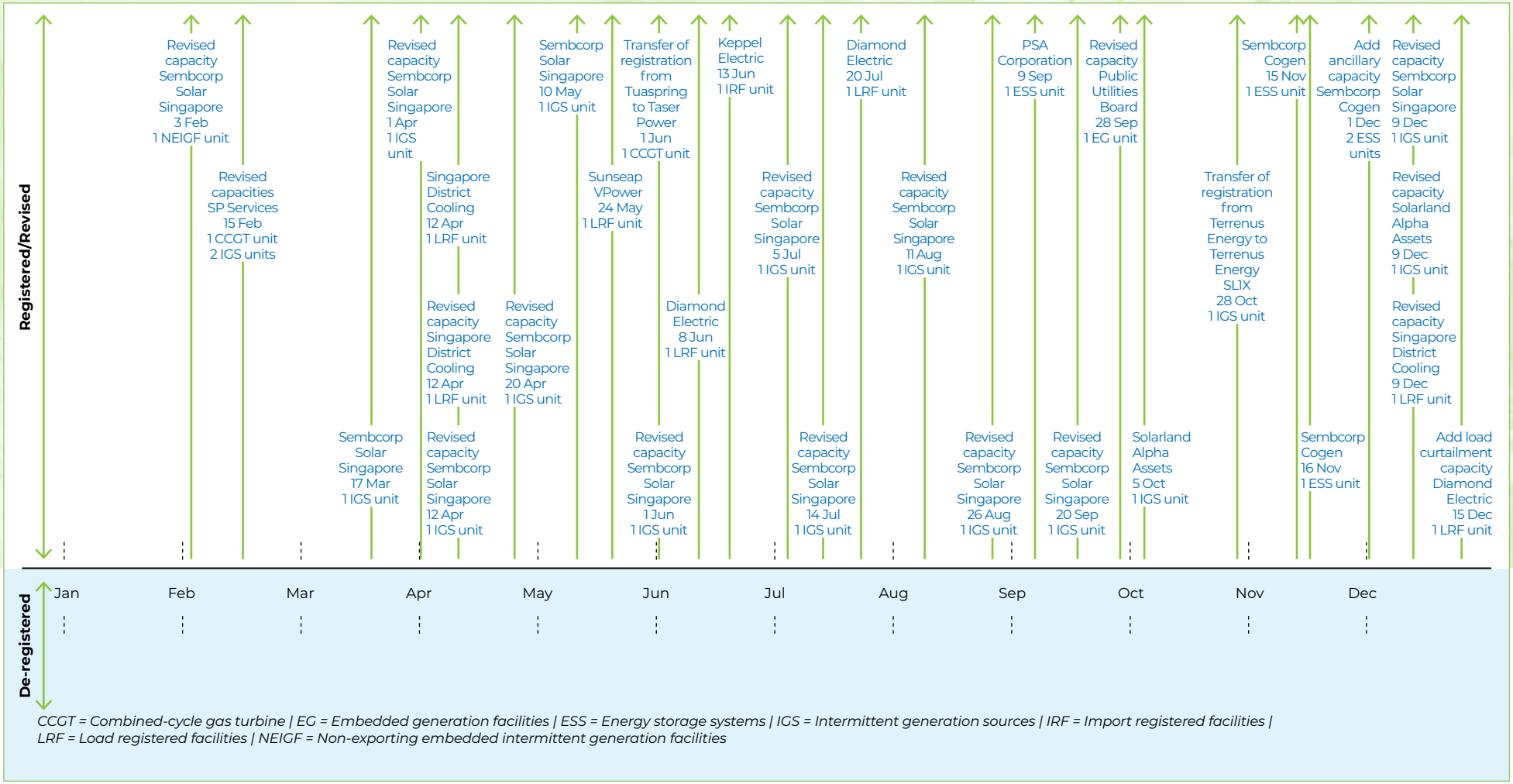
The annual forecasted demand rose 1.9 percent in 2022 to 6,300MW. The monthly forecasted demand reached new highs from January to September.

Compared to 2021, demand was stronger in all months except October, November and December. The steepest YOY demand growth was in January at 8.2 percent, which corresponded to the highest temperature increase of 1.6 degrees Celsius compared to January 2021. The temperature increase came off the low base set in January 2021 when the monthly temperature was the lowest since year 2017 and the economy had only just begun reopening in January 2021 following Covid-19 Phase 2 heightened alert status. The highest monthly demand in 2022 was 6,430MW in May, which recorded the second highest temperature rise of 0.5 degree Celsius compared to May 2021.

The peak half-hourly demand in 2022 climbed to a new record high of 7,371MW in Period 34 on 31 May, which was 0.8 percent higher than 2021's peak of 7,315MW recorded in Period 33 on 11 August 2021.

ENERGY SUPPLY

Generation and Load Facilities Registered, De-registered and Revised in 2022



CCGT = Combined-cycle gas turbine | EG = Embedded generation facilities | ESS = Energy storage systems | IGS = Intermittent generation sources | IRF = Import registered facilities | LRF = Load registered facilities | NEIGF = Non-exporting embedded intermittent generation facilities

ENERGY SUPPLY

11 new facilities registered in 2022 including the first import facility

At the end of 2022, the total registered capacity[12] of generation facilities in the NEMS stood at 12,563MW. Out of this, 83.8 percent or 10,522MW belonged to the CCGT/cogen/trigen category. As at 31 December 2022, there were 111 generation facilities, nine load facilities, one import facility and four ESS facilities registered in the NEMS.

During the year, 11 new facilities were added from eight MPs which collectively contributed three intermittent generation source (IGS)[13] facilities, four load facilities, one import facility, and three ESS facilities to the market. In addition, one CCGT facility, six IGS facilities, two load facilities, two ESS facilities and one EG facility registered capacity additions and revisions throughout the year.

With regard to de-registrations, Tuaspring and Terrenus Energy were deregistered in 2022. Prior to Tuaspring's withdrawal from the market, the registration of its 395.7MW generation facility was transferred to Taser Power. Likewise, Terrenus Energy's 4.65MW IGS unit was transferred to Terrenus Energy SL1X.

New Facilities Registered

Market Participant	Generation Type	Registered Capacity
Sembcorp Solar Singapore	2 IGS units	0.460MW, 1.200MW
Singapore District Cooling	1 LRF unit	4.000MW for load curtailment, 4.000MW for contingency reserve
Sunseap VPower	1 LRF unit	0.100MW for contingency reserve
Diamond Electric	2 LRF units	2.700MW for contingency reserve, 7.200MW for contingency reserve
Keppel Electric	1 IRF unit	100.000MW
PSA Corporation	1 ESS unit	3.500MW[14]
Solarland Alpha Assets	1 IGS unit	1.600MW
Sembcorp Cogen	2 ESS units	100.000MW each for generation

Capacity Revisions

Market Participant	Generation Type	Revised Capacity
Public Utilities Board	1 EG unit	5.902MW
Sembcorp Solar Singapore	1 NEIGF unit	9.310MW
Sembcorp Solar Singapore	2 IGS units	3.040MW, 9.036MW
Singapore District Cooling	1 LRF unit	7.000MW for load curtailment and 7.000MW for contingency reserve
SP Services	1 CCGT unit (under ECIS[15])	14.696MW
SP Services	2 IGS units (under ECIS)	5.033MW, 211.199MW
Solarland Alpha Assets	1 IGS unit	2.600MW

Capacity Additions

Market Participant	Generation Type	Added Capacity
Sembcorp Cogen	2 ESS units	100.000MW each for reserve, 100.000MW each for regulation
Diamond Electric	1 LRF unit	7.200MW for load curtailment

12 In 2021, registered capacity including energy storage systems was 12,170MW. In 2022, registered capacity included energy storage systems and imports.
13 Includes NEIGFs registered in 2022.
14 The actual generation capacity is 1.700MW, with a modelled capacity of 3.500MW.
15 Enhanced Central Intermediary Scheme for Embedded Generation.

ENERGY SUPPLY

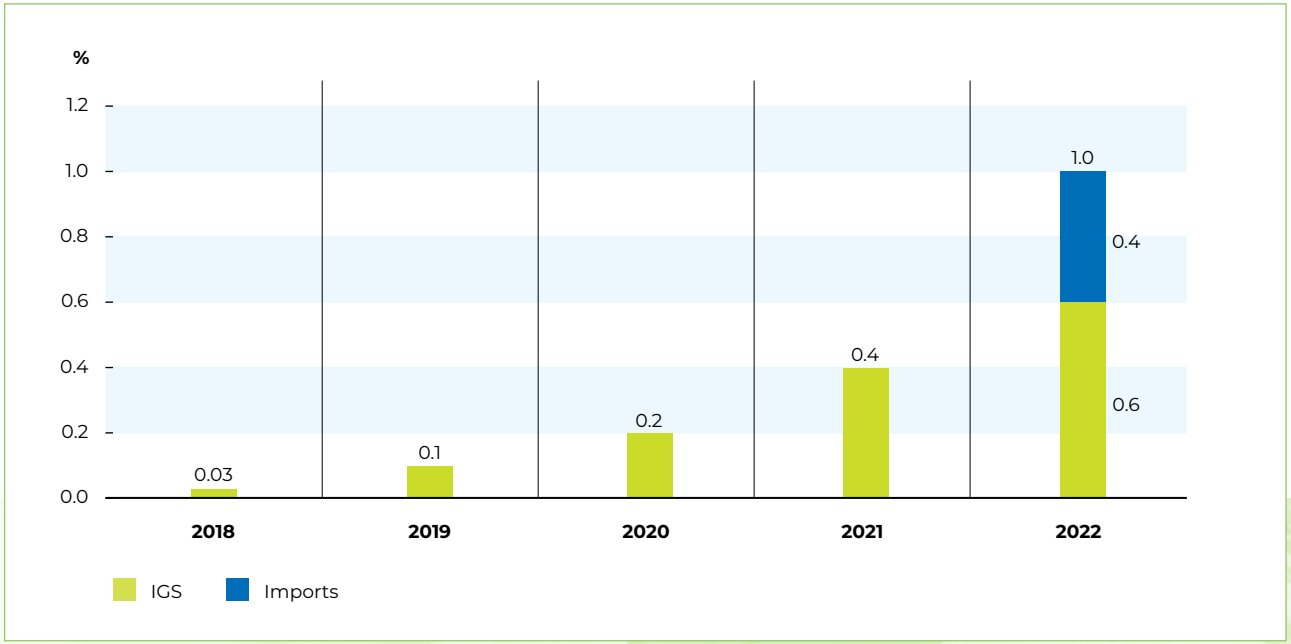
Renewable generation market share increases significantly

Renewable generation in the NEMS refers to the generation from IGS and import facilities.

The combined market share of renewable generation has been growing at an increasing rate since 2018. In line with the increase in the proportion of renewable generation registered capacity to the total registered capacity in 2022, the YOY growth in market share tripled from 0.2 percentage point growth in 2021 to 0.6 percentage point growth in 2022.

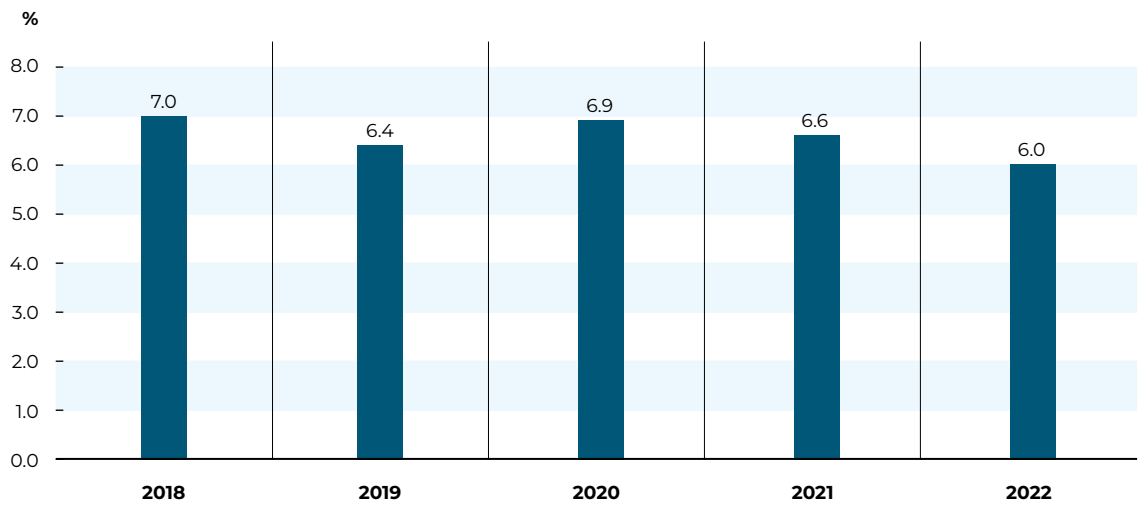
Among the renewable generation types, IGS continued to dominate the market share at 0.6 percent in 2022, up from 0.4 percent in 2021.

Renewable Generation Market Share 2018–2022 (Based on Metered Generation)



ENERGY SUPPLY

Embedded Generator Generation Market Share 2018–2022



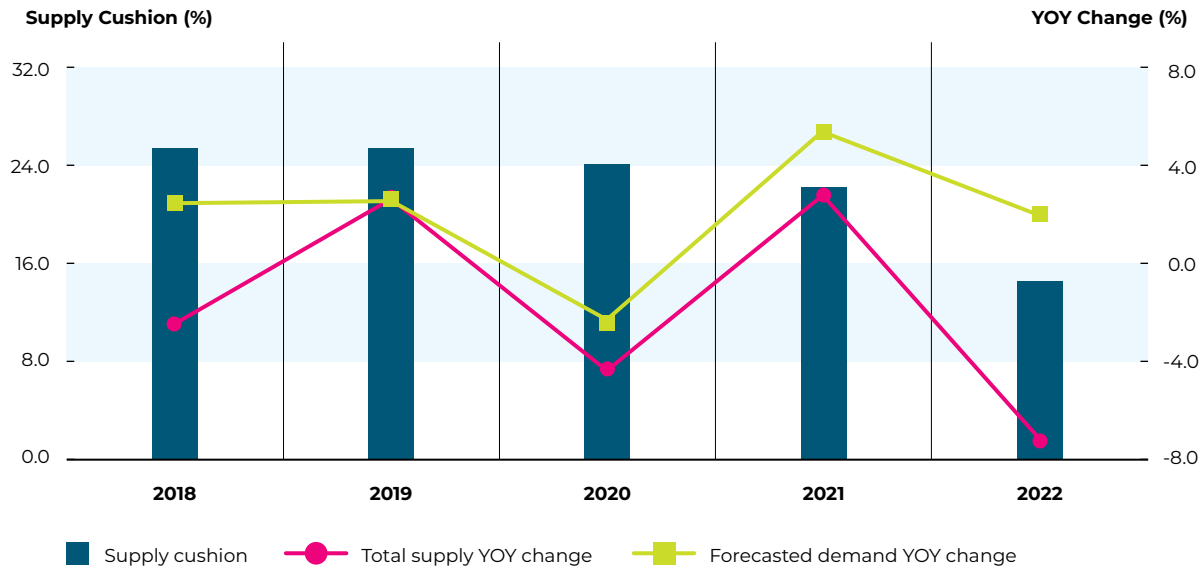
Embedded generator generation market share extends its decline in 2022

The market share of embedded generators (EGs) in the NEMS dropped for the second consecutive year in 2022, by 0.6 percentage point to 6.0 percent, due to higher maintenance of EG facilities.

The highest monthly EG generation market share in the year was registered in January at 7.3 percent, while the lowest was in November at 4.5 percent. The standard deviation was 1.01 percent, up from 2021's standard deviation of 0.66 percent.

ENERGY SUPPLY

Annual Supply Cushion 2018–2022



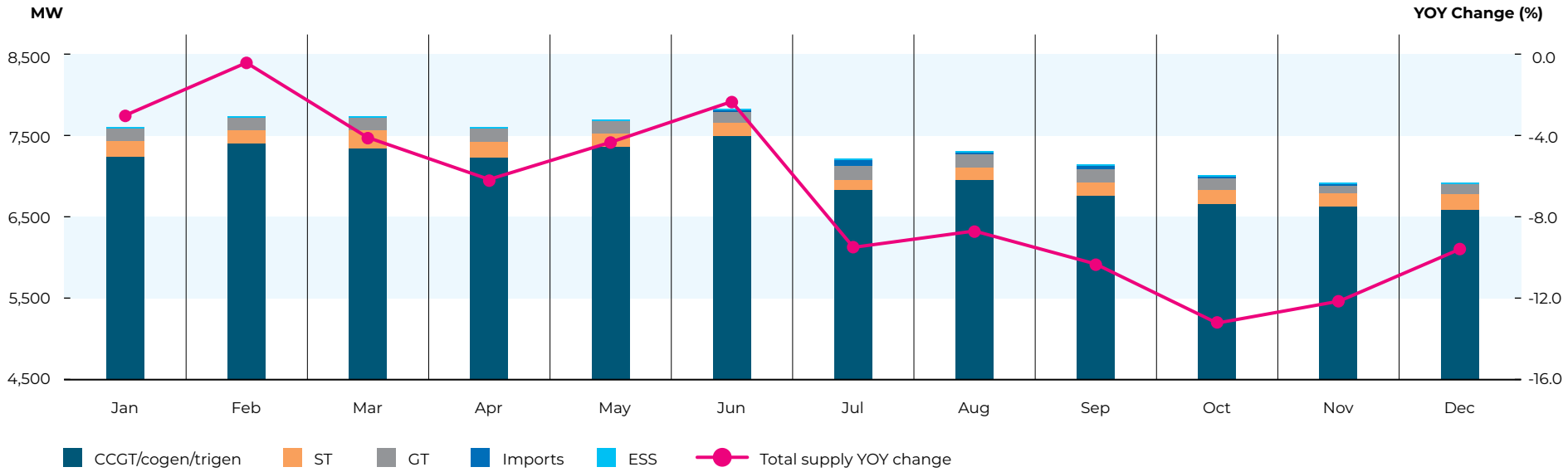
Supply cushion contracts sharply to a new record low

The supply cushion measures the percentage of total generation supply that is available after matching off forecasted demand. It is calculated by subtracting forecasted demand from total supply, over total supply.

In 2022, the forecasted demand increased 1.9 percent while total supply plunged 7.1 percent, thereby shrinking the supply cushion by 7.7 percentage points to a historic low of 14.5 percent. The supply cushion reduction was also the steepest since the market started.

ENERGY SUPPLY

Monthly Supply by Plant Type 2022



Total supply registers YOY decline in all months

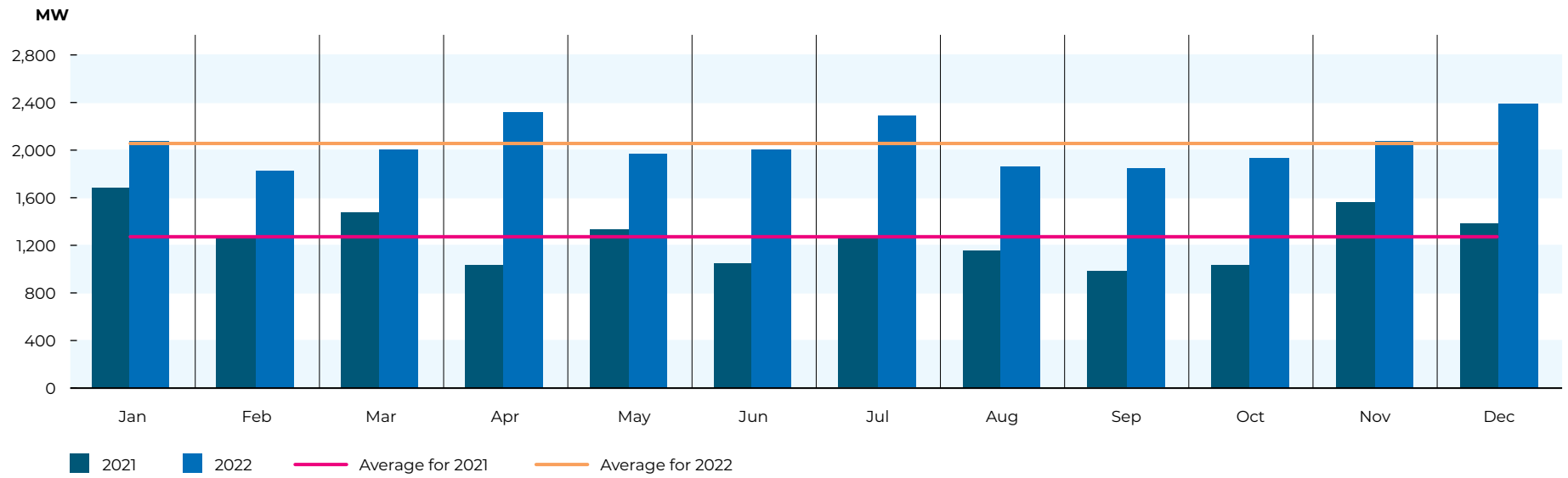
In line with more frequent upstream gas curtailment YOY, total supply shrank between 0.3 and 13.2 percent in all months compared to 2021. The largest YOY decline occurred in October while the smallest YOY decline was in February.

The most efficient generation type – CCGT/cogen/trigen – continued to dominate with a 95.3 percent share of the total supply. This was a 1.1 percentage point drop from their proportion in 2021. The proportion of ST supply increased 0.7 percentage point to 2.3 percent, while that of GT supply remained at 2.0 percent. The proportion of import supply averaged 0.3 percent for the year, while that of ESS supply continued to make up less than 0.1 percent.

In 2022, the monthly supply fell below the 8,000MW level in all months, highlighting the weaker supply this year compared to the past few years. The monthly supply was the highest in June at 7,781MW, and the lowest in December at 6,905MW. Compared to the first half of the year, the total supply averaged 7.7 percent lower in the second half of the year.

ENERGY SUPPLY

Monthly Generation Maintenance 2021 Versus 2022



Generation maintenance increases in 2022

The annual average generation maintenance level[16] increased 61.5 percent in 2022 to 2,050MW. The monthly generation maintenance levels were higher YOY in all months. The highest monthly average generation maintenance level of 2,396MW was in December, while the lowest level of 1,821MW was in February.

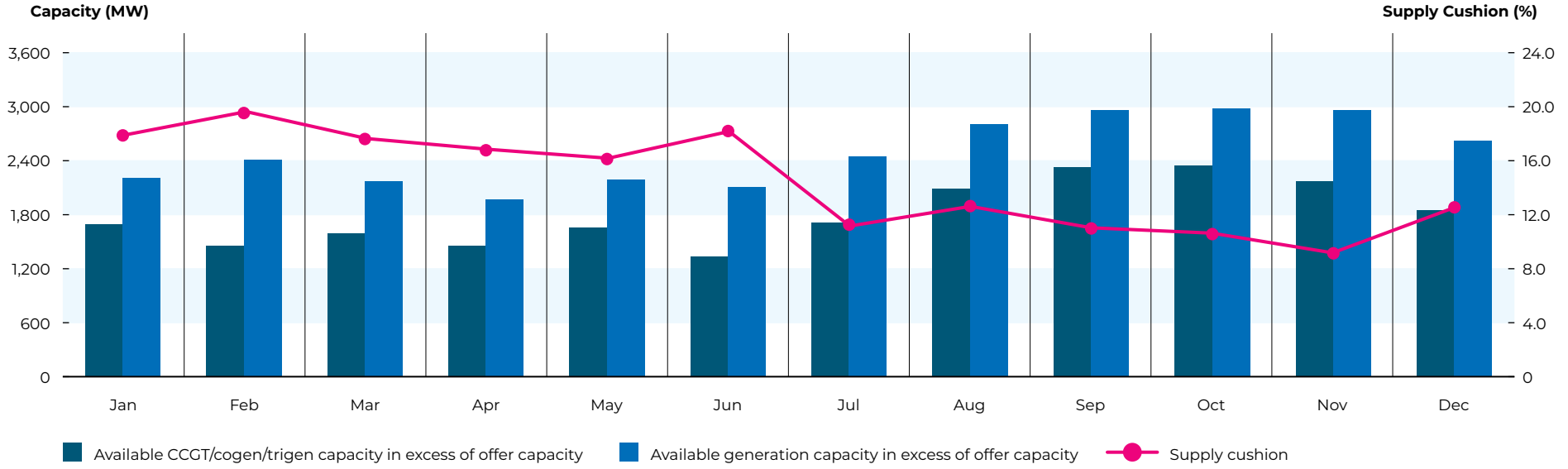
The standard deviation of monthly generation maintenance stabilised from 230MW in 2021 to 191MW in 2022, as the monthly generation maintenance range narrowed to between 1,821MW and 2,396MW.

The ratio of generation maintenance to registered capacity[17] increased from 10.4 percent in 2021 to 16.3 percent in 2022.

16 Generation maintenance refers to the overhaul and retrofitting of generation facilities. Generation maintenance levels are calculated based on the Annual Generator Outage Programme (AGOP) provided by the PSO.
17 In 2021, registered capacity including energy storage systems was 12,170MW. In 2022, registered capacity included energy storage systems and imports.

ENERGY SUPPLY

Monthly Supply Cushion and Available Generation Capacity in excess of Offer Capacity 2022



Increasing available generation capacity in excess of offer capacity reflected in decreasing supply cushion

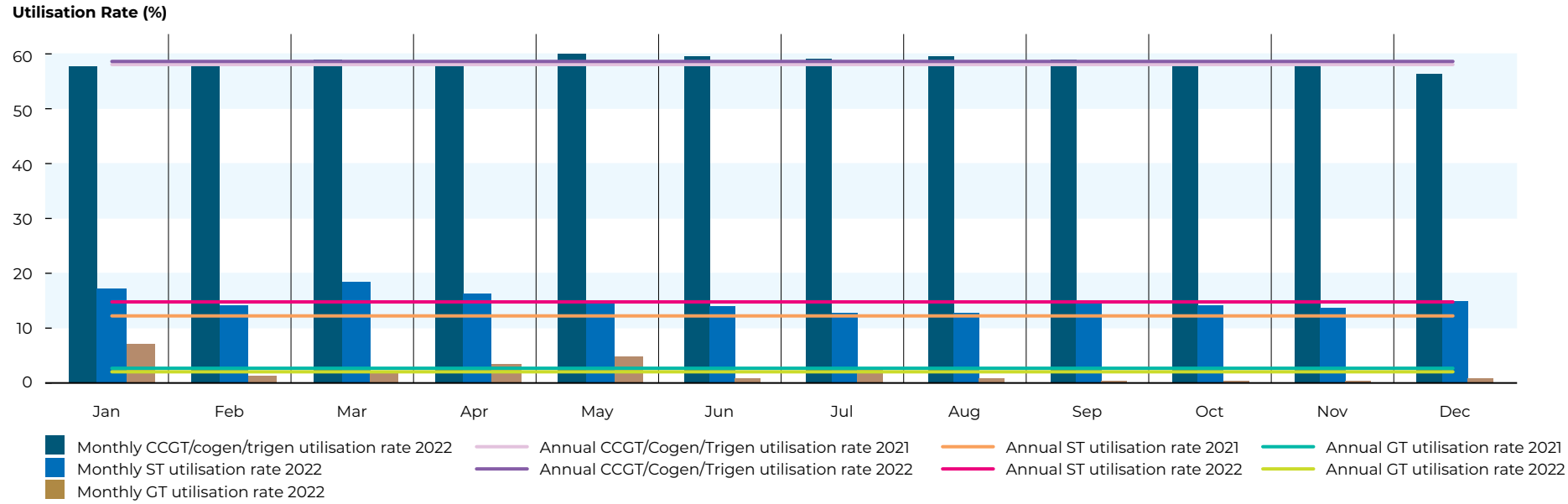
Available generation capacity in excess of offer capacity refers to the generation capacity which is not on maintenance and not being offered to the market.

At the monthly level, the available generation capacity in excess of offer capacity peaked at 2,987MW in October when the supply cushion was the second lowest in the year at 10.7 percent. The lowest available generation capacity in excess of offer capacity was recorded in April at 1,983MW. Throughout 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.

Compared to the first half of the year, the available generation capacity in excess of offer capacity averaged 35.5 percent higher in the second half of the year. Correspondingly, the supply cushion averaged 6.5 percentage points lower in the second half of the year. Referencing to upstream gas curtailment, more frequent and higher percentage of upstream gas curtailment was observed in the second half of the year as well.

ENERGY SUPPLY

Monthly Utilisation Rate by Plant Type 2022



Mixed movements in utilisation rates

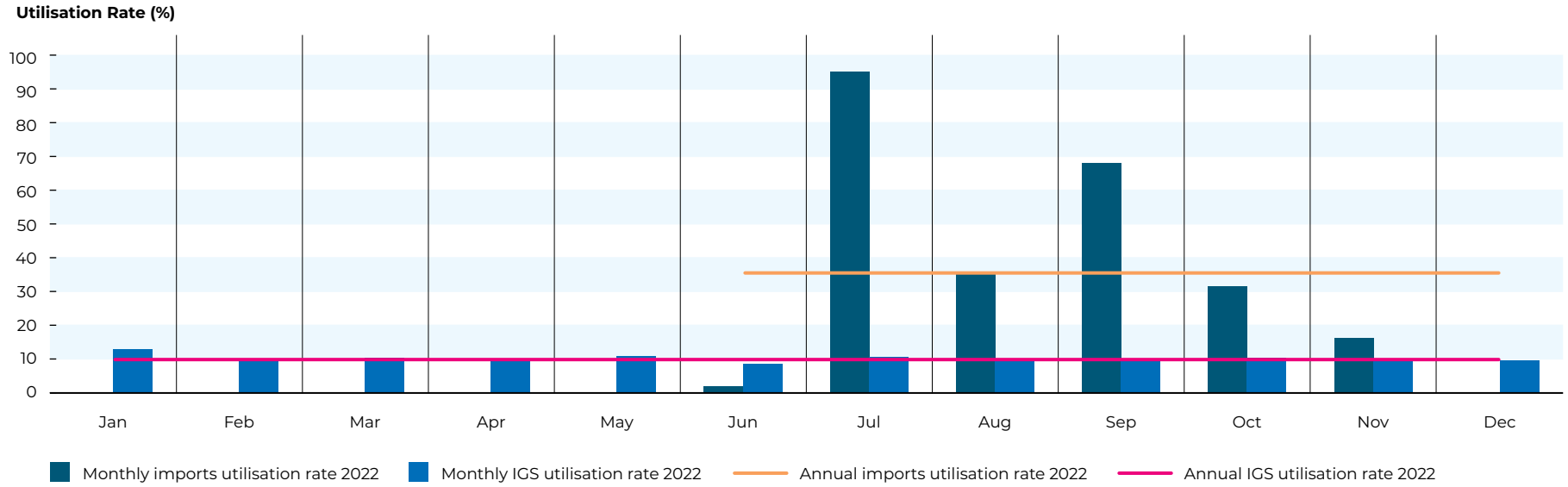
Utilisation rate is the ratio of the scheduled energy to the maximum generation capacity defined in the standing capability data. In 2022, the annual CCGT/cogen/trigen utilisation rate rose 0.6 percentage point to 58.4 percent. The annual ST utilisation rate improved 2.5 percentage points to 14.6 percent, while that of GT dipped 0.7 percentage point to 1.9 percent.

On a monthly basis, the CCGT/cogen/trigen utilisation rate ranged between 56.2 percent in December and 59.8 percent in May, while that of ST ranged between 12.5 percent in July and 18.1 percent in March. The GT utilisation rate peaked in January at 6.9 percent and reached a low of less than 0.1 percent in November.

Compared to 2021, the CCGT/cogen/trigen utilisation rate was higher in eight out of the 12 months, with the largest increase of 3.7 percentage points recorded in January. The ST utilisation rate was higher in all months except November, with the largest increase of 5.0 percentage points seen in March. The GT utilisation rate was higher from January to August, and lower thereafter. The steepest growth in GT utilisation rate at 6.9 percentage points was in January when the GT utilisation rate was zero in the same month in 2021.

ENERGY SUPPLY

Monthly Utilisation Rate by Plant Type 2022



Since the inception of import generation in June, the annual import utilisation rate averaged 35.8 percent for the year. The import utilisation rate hit a high of 95.5 percent in July, and decreased thereafter due to higher maintenance.

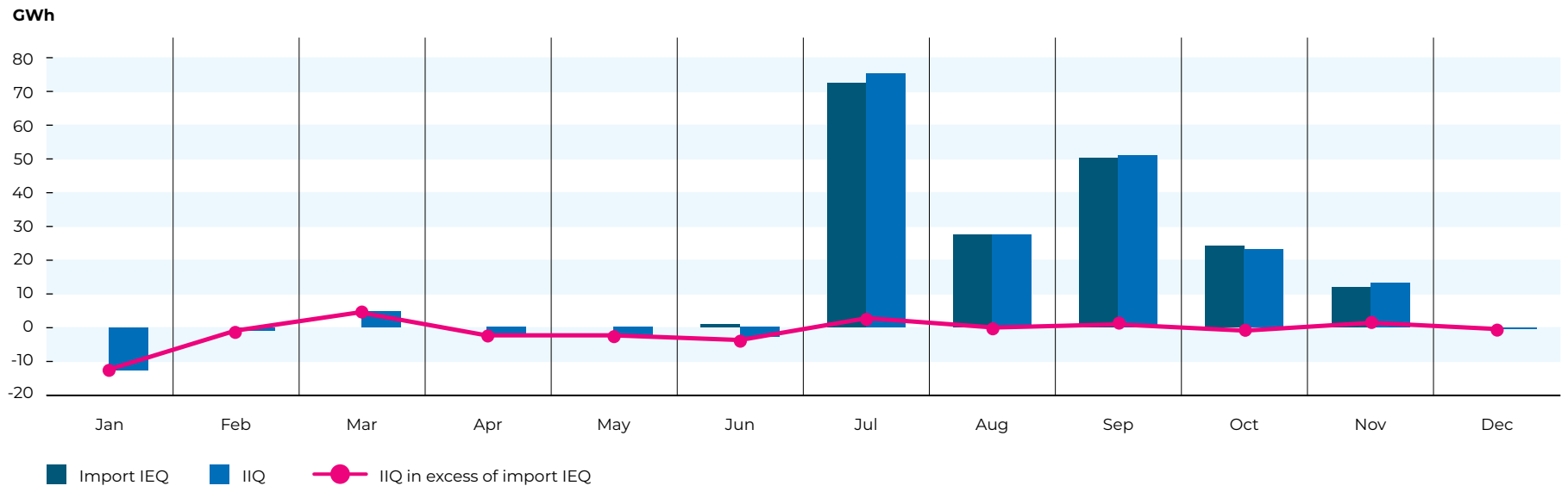
The annual IGS utilisation rate[18] averaged 10.2 percent. At the monthly level, it ranged between 8.7 percent in June and 13.1 percent in January.

ESS utilisation rates[19] were low throughout the year.

18 Based on a proxy for IGS utilisation rate.
19 Based on actual generation capacity.

ENERGY SUPPLY

Monthly Import Generation and Net Imported Intertie Quantities 2022



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

Net imported intertie quantity follows import generation quantity closely

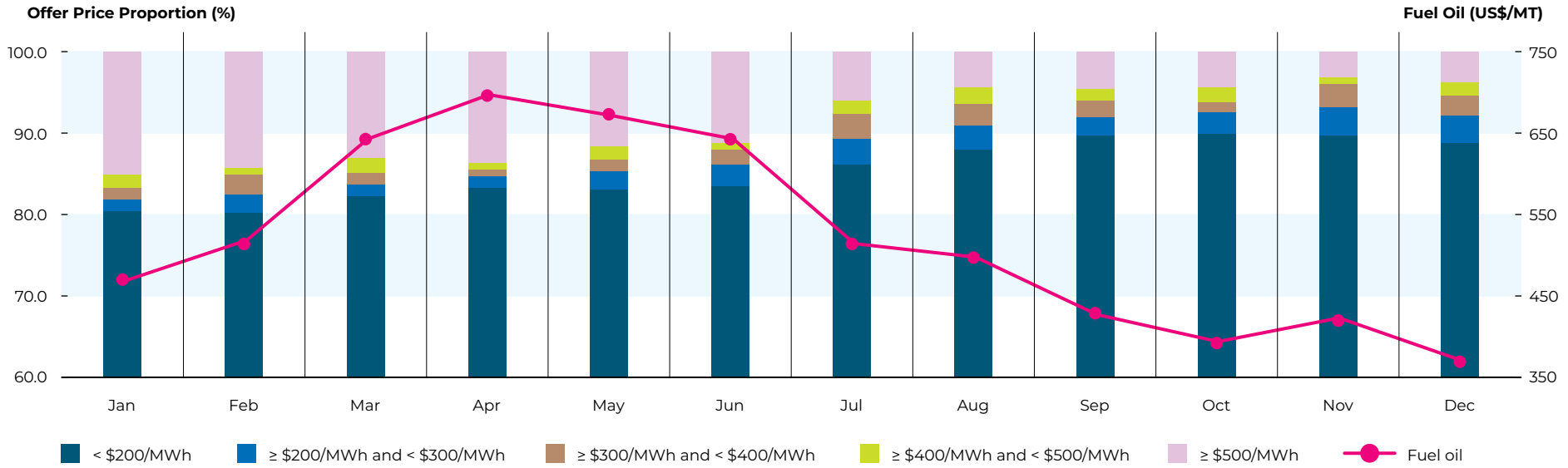
Import generation quantity (Import IEQ) refers to the flow from import facilities. Net imported intertie quantity (IIQ) refers to the flow into or out of the transmission system due to intertie flows.

Prior to the inception of import generation on 23 June, the IIQ was negative in most months, ranging between -12.5GWh in January and 4.5GWh in March. From July onwards, the IIQ turned largely positive and trended closely with the Import IEQ.

Since the month of June, the IIQ in excess of the Import IEQ ranged between -3.7GWh and 2.6GWh. The maximum occurred in July which coincided with the highest monthly IIQ and Import IEQ in the year. The minimum was in June when the monthly IIQ and Import IEQ were the lowest.

ENERGY SUPPLY

Monthly Energy Offer Price Proportion and Fuel Oil Price 2022



Energy offer prices and fuel oil prices move in tandem

In 2022, the daily fuel oil price ranged between US$358.87 per metric tonne (MT) and US$711.86/MT. The highest monthly level of US$696.68/MT was registered in April, while the lowest monthly level of US$372.49/MT was recorded in December.

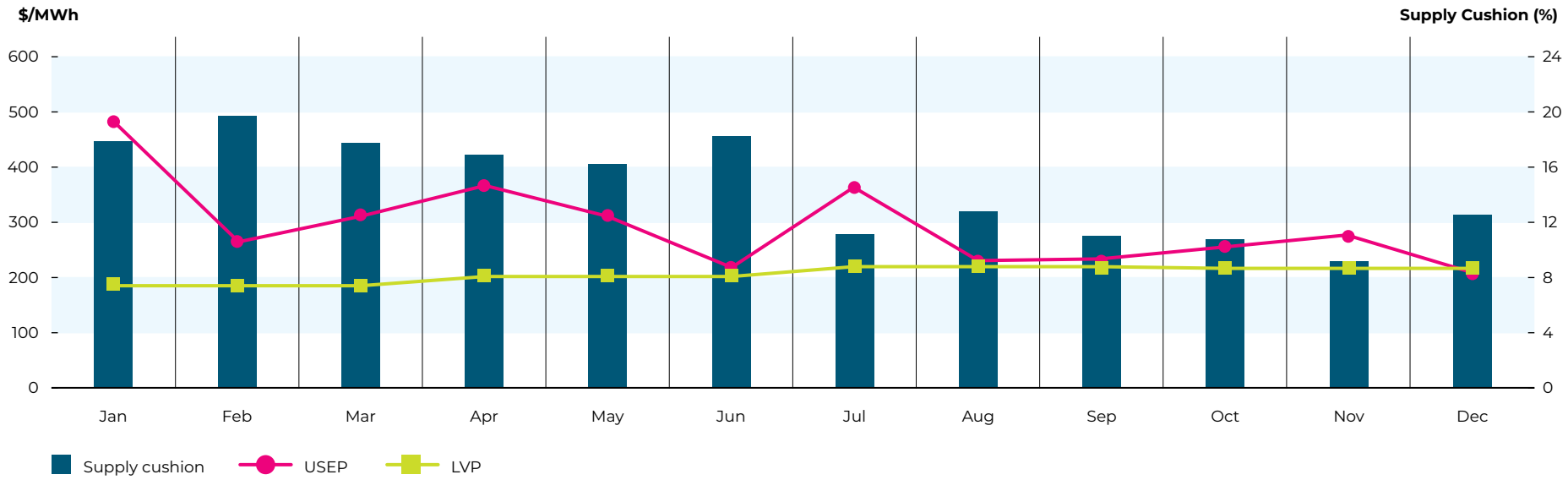
Fuel oil prices jumped from US$469.11/MT in January to US$696.68/MT in April, underlining the impact of fuel oil supply brought on by the easing of Covid-19 restrictions and geopolitical conflicts. Thereafter, fuel oil prices began to fall gradually for the remaining months.

Throughout 2022, the proportion of energy offers moved largely in line with fuel oil prices on a monthly basis. In the first half of the year when the fuel oil prices ranged from US$469.11/MT to US$696.68/MT, the proportion of energy offers above $500.00/MWh ranged from 11.2 to 15.1 percent. Then, in the second half of the year, the proportion of energy offers above $500.00/MWh ranged from 3.1 to 6.1 percent, as the fuel oil prices dropped below US$600.00/MT.

The proportion of energy offers below $200.00/MWh averaged above 80.0 percent for all months, reaching a peak of 89.9 percent in October when fuel oil prices tumbled to the year's second lowest monthly level.

ENERGY PRICES

Monthly USEP, LVP and Supply Cushion 2022



USEP remains above LVP benchmark in most months

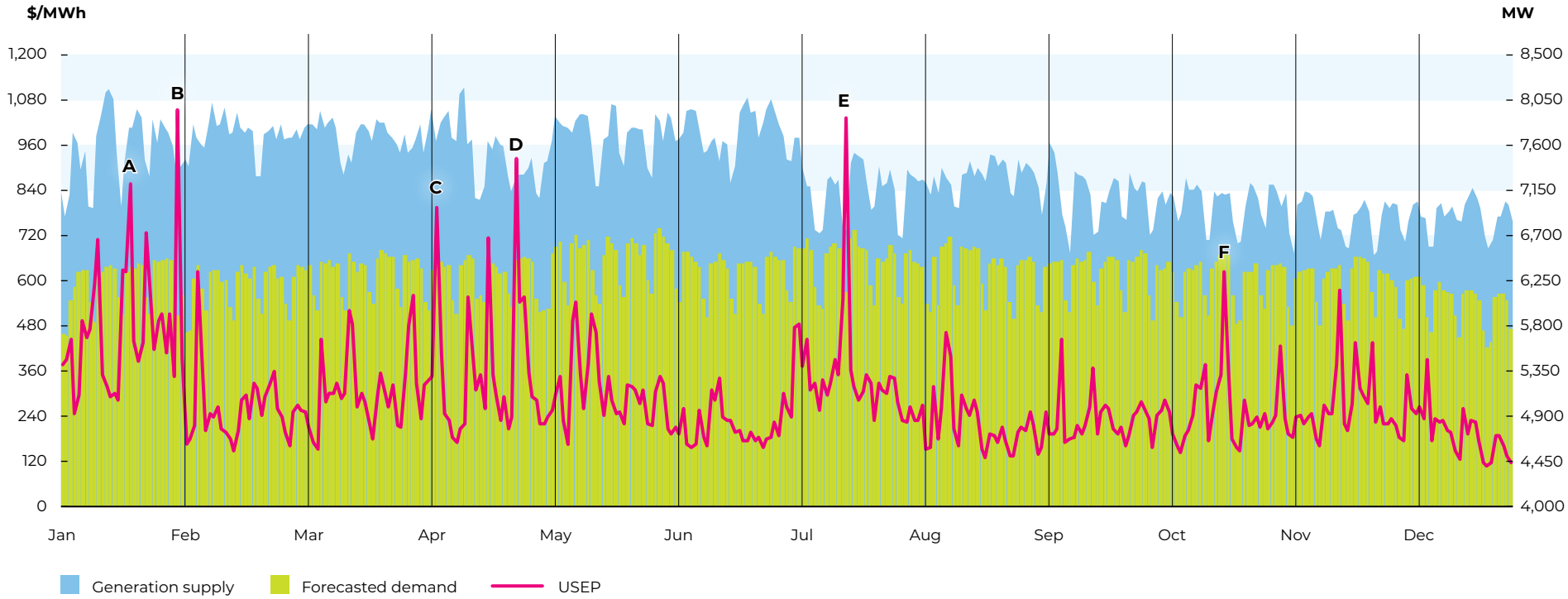
In 2022, the USEP registered above the LNG Vesting Price (LVP) in all months except December. The difference of $272.83/MWh between the monthly minimum USEP of $207.38/MWh in December and the monthly maximum USEP of $480.21/MWh in January was significantly lower when compared to the $413.43/MWh in 2021.

The annual average USEP compared to the annual average LVP is $87.07/MWh or 29.8 percent higher. The gap was more than double of the $43.24/MWh gap observed in 2021. At the monthly level, the largest absolute gap between the monthly USEP and the monthly LVP was in January, when the USEP was $297.36/MWh above the LVP, while the smallest absolute gap was observed in December when the USEP was $7.40/MWh below the LVP. The gap was narrower in the second half of the year compared to the first half.

The monthly supply cushion was below 20.0 percent in all months. The supply cushion averaged 14.5 percent in 2022, which was 7.7 percentage points lower than 2021's, and was the lowest since the market started.

ENERGY PRICES

Daily USEP, Forecasted Demand and Generation Supply 2022



The key observations on the USEP fluctuations in 2022 were as follows:

Point A: On 18 January (Tuesday), three CCGT units and one EG unit were on planned maintenance, while another CCGT unit was on unplanned maintenance. Separately, one CCGT experienced forced outage in Period 36. The daily average USEP was $856.58/MWh and the daily average supply cushion was 17.8 percent.

The USEP climbed above $1,000.00/MWh from Period 28 to Period 35, and from Period 38 to Period 44. During these 15 periods, the supply cushion ranged from 9.0 to 12.3 percent. Contingency reserve shortfall was registered in Period 29 and from Period 42 to Period 44, and one GT unit was scheduled from Period 35 to Period 45. The PSO advised that the power system was at a high-risk operating state in Periods 29 and 42, and in an emergency operating state from Period 43 to Period 44.

Point B: On 30 January (Sunday), the daily average USEP was $1,054.62/MWh. This was the highest daily average in the year, attributing to the periodic USEP exceeding $1,000.00/MWh for a total of 15 periods from Period 31 to Period 45. The supply cushion in these periods ranged between 10.1 and 13.6 percent, which was comparatively lower than the average supply cushion for the day of 19.6 percent. Amongst these periods, one GT unit was scheduled from Period 41 to Period 42 while demand response (DR) curtailment was scheduled from Period 31 to Period 36. On that day, three CCGT units and one EG unit were on planned maintenance, and another CCGT unit was on unplanned maintenance.

ENERGY PRICES

Point C: On 5 April (Tuesday), there were two CCGT units and three EG units on planned maintenance, another two CCGT units on unplanned maintenance and two other CCGT units on partial unplanned maintenance.

The PSO advised that the power system was at a high-risk operating state in Period 17, when the supply cushion fell to 9.4 percent, the USEP soared to $4,145.17/MWh, and contingency reserve shortfall was recorded. Contingency reserve shortfall continued till Period 22, during which the PSO declared that the power system was in an emergency operating state from Period 18 to Period 22, during which the USEP ranged between $1,108.27/MWh and $3,126.43/MWh while the supply cushion ranged between 7.8 and 9.1 percent. In addition, Demand Response (DR) curtailment was scheduled from Period 22 to Period 24, and one GT unit was scheduled to run in Period 18 and from Period 20 to Period 34. Thereafter, the USEP returned to above $1,000.00/MWh from Period 39 to Period 42 when the supply cushion ranged between 10.8 and 11.5 percent. The average USEP over the day was $797.75/MWh against an average supply cushion of 15.7 percent.

Point D: On 25 April (Monday), there were two CCGT units and two EG units on planned maintenance, another two CCGT units on unplanned maintenance, and one other CCGT unit on partial unplanned maintenance.

Compared to the previous Monday, the average demand of 6,464MW was 0.9 percent higher while the average supply of 7,291MW was 4.9 percent lower. This led to a 5.1 percentage point contraction in the supply cushion to 11.3 percent, and correspondingly, a 29.1 percent rise in the average USEP.

On a periodic level, the USEP settled above $1,000.00/MWh from Period 19 to Period 21, in Period 28, from Period 31 to Period 35 and in Period 43. During these periods, the supply cushion ranged between 4.0 and 6.9 percent. One GT unit was scheduled from Period 17 to Period 39. In addition, DR curtailment was scheduled from Period 17 to Period 25, from Period 27 to Period 28, and from Period 30 to Period 44. As contingency reserve shortfall (in Period 30 and from Period 33 to Period 35) and regulation shortfall (in Period 34) were observed, the PSO advised that the power system was at a high-risk operating state in Periods 30 and 33, and in an emergency operating state from Period 34 to Period 35.

Point E: On 17 July (Sunday), the average USEP was $1,034.23/MWh. This was the second highest daily average in the year, against the supply cushion averaging at 9.1 percent for the day. Two CCGT units and two EG units were on planned maintenance, while three other CCGT units and one other EG unit were on unplanned maintenance.

The USEP spiked in Period 38 and from Period 41 to Period 47, settling between $4,291.98/MWh and $4,499.99/MWh. Notably, the USEP of $4,499.99/MWh in Periods 38 and 45 was the second highest periodic level recorded in the year. The supply cushion for these eight periods ranged between 3.2 and 5.4 percent. For the remaining periods of the day, the range of supply cushion was between 4.5 and 14.9 percent, while that of USEP was between $249.75/MWh and $807.77/MWh.

During these periods of high USEP levels, one GT unit was scheduled from Period 41 to Period 47, while another GT unit was scheduled from Period 38 to Period 40 and from Period 45 to Period 47. Contingency reserve shortfall was recorded in Period 38 and from Period 41 to Period 44, while regulation shortfall was recorded from Period 37 to Period 41. The PSO advised that the power system was at a high-risk operating state in Period 37, and in an emergency operating state in Period 38.

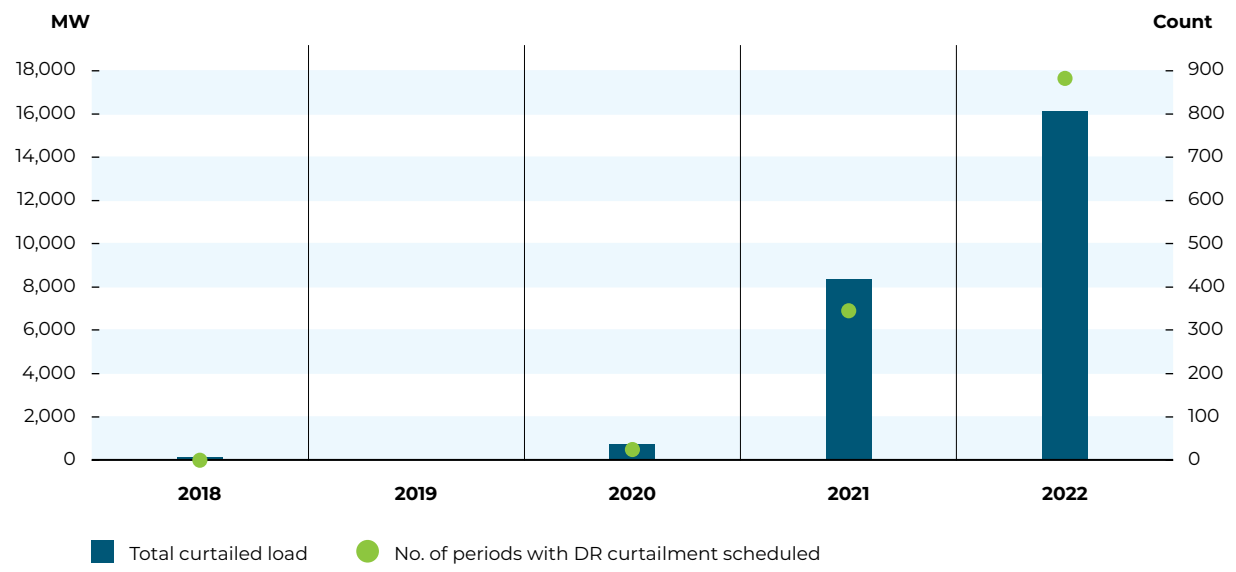
Point F: On 20 October (Thursday), compared to the previous Thursday, the average demand of 6,555MW was 2.1 percent higher while the average supply of 7,122MW was 1.2 percent lower. This resulted in a 3.0 percentage point contraction in the supply cushion to 8.0 percent. This was the sixth lowest daily average supply cushion in the year, as well as the seventh lowest daily average since the market started. The average USEP nearly doubled from the previous Thursday to $627.96/MWh.

There were three CCGT units and one EG unit on planned maintenance, one other CCGT unit and two other EG units on unplanned maintenance, and another CCGT unit on partial unplanned maintenance. One import facility was suspended in Period 7 due to upstream disturbance and went on unplanned maintenance from Period 35 onwards.

Over the course of the day, the supply cushion ranged between 1.6 and 14.0 percent. Notably, the supply cushion of 1.6 percent in Period 43 was the lowest periodic level in the year and the fifth lowest periodic level since the market started. The USEP rose above $1,000.00/MWh from Period 18 to Period 24, in Period 34 and from Period 36 to Period 43, during which it peaked at $3,723.10/MWh in Period 43. Two GT units were scheduled in Period 43, while DR curtailment was scheduled from Period 30 to Period 32. Contingency reserve and regulation shortfalls were observed in Period 18. Thereafter, contingency reserve shortfall was again recorded from Period 20 to Period 23, and in Periods 25 and 33. The PSO advised that the power system was at a high-risk operating state in Periods 18, 20, 25, and 33, and in an emergency operating state in Period 21.

DEMAND RESPONSE

Annual Demand Response Curtailment Scheduled 2018–2022



Number of periods with Demand Response curtailment sets new record in 2022

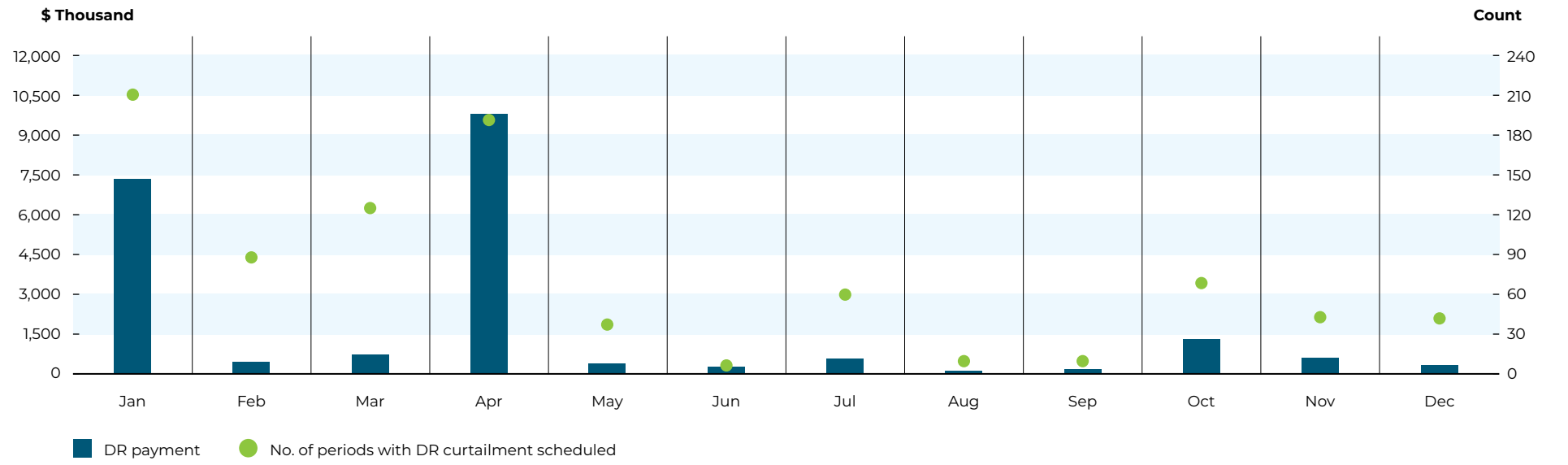
The Demand Response (DR) programme was introduced in 2016 to enable contestable consumers to participate directly in the wholesale market by reducing their electricity demand voluntarily in response to market conditions. This is particularly during periods of high wholesale market prices or when system reliability has been adversely affected.

A total of 883 periods with DR curtailment in 2022 beat an already record-breaking 343 in the previous year, on the back of the number of trading periods with USEP above $500.00/MWh increasing from 942 in 2021 to 1,235 in 2022. The total curtailed load in 2022 was at 16,008MW, up by 94.2 percent from 2021.

As at 31 December 2022, there were three DR providers and four DR facilities in the market.

DEMAND RESPONSE

Monthly Demand Response Payment 2022



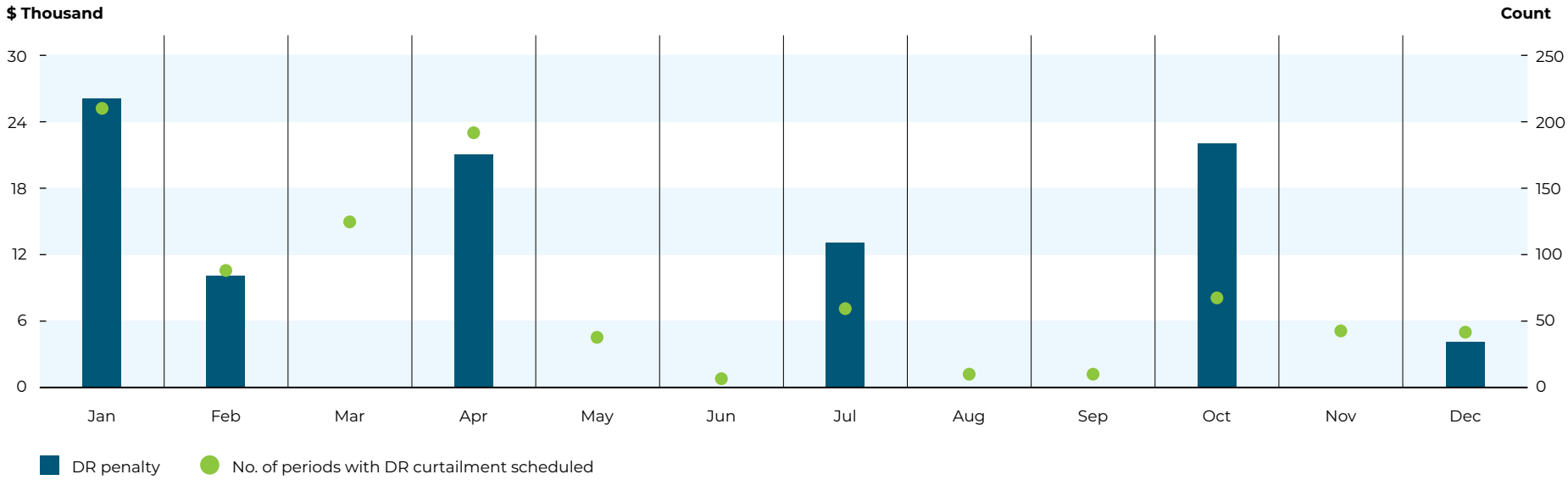
DR payment amount increases while the penalty amount decreases

Compared to 2021, the spread between the Counterfactual Uniform Singapore Energy Price (CUSEP) and USEP in 2022 narrowed to between -$0.02/MWh and $2,276.78/MWh, and averaged lower at $75.47/MWh. This indicates that with each MW, consumers benefitted less from the lower estimated average cost savings of $75.47/MWh in 2022, compared to $174.30/MWh for each MW in 2021.

The annual DR payment amounted to $21.3 million in 2022, up by 60.2 percent from $13.3 million in 2021. There were DR payments in all 12 months in 2022, compared to eight such months in 2021. The number of periods with DR curtailment in a month was the highest in January at 210 when the DR payment was at $7.3 million. The DR payment was the highest in April at $9.8 million when there were 191 periods with DR curtailment.

DEMAND RESPONSE

Monthly Demand Response Penalty 2022



The annual DR penalty totalled $96,253.91 in 2022, down by 16.9 percent from $115,884.12 in 2021. The DR penalty amount peaked in January for the year at $26,245.28.

The DR penalty accounted for a 0.5 percentage point lower proportion of the total DR amount transacted, at 0.4 percent.

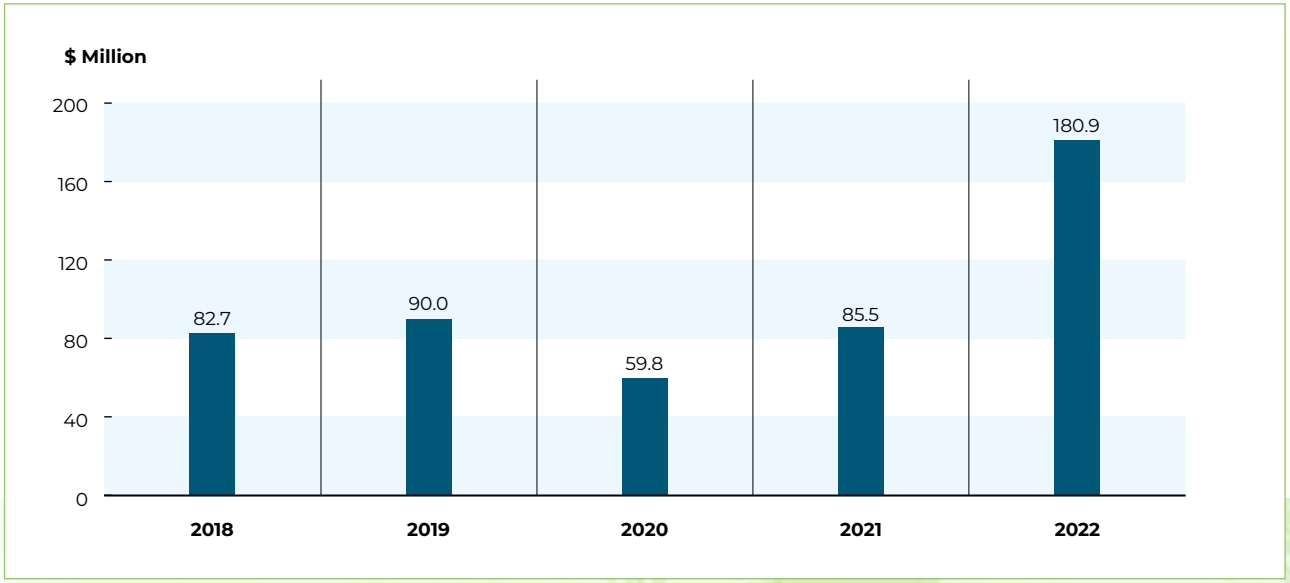
ANCILLARY MARKETS

Reserve payment hits an all-time high

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 ten minutes for contingency reserve. The generators bear the cost of procuring the reserves.

Reserve costs nearly doubled from $85.5 million in 2021 to $180.9 million in 2022, which was the highest level since the market started. This was driven by higher reserve prices in 2022.

Annual Reserve Payment 2018–2022



ANCILLARY MARKETS

Higher overall responsiveness of reserve providers

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

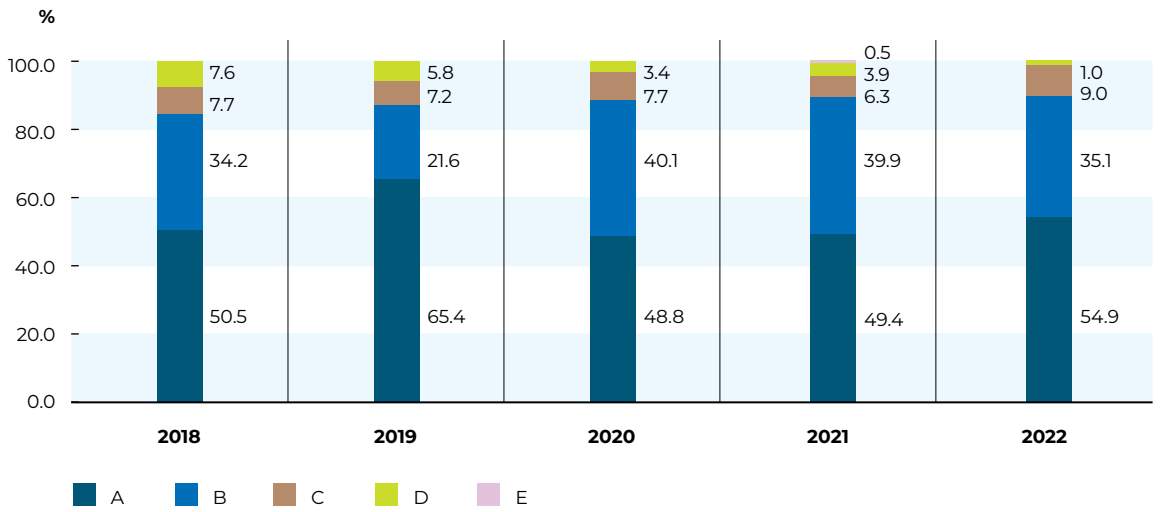
In 2022, some of the reserve providers in Groups B, D and E moved into Groups A and C. The percentage of reserve providers in Groups A and C increased 5.5 and 2.7 percentage points respectively, while that for Groups B, D and E decreased 4.8, 2.9 and 0.5 percentage point respectively.

Notably, Group A's proportion of 54.9 percent is at its highest since 2020, while Group C recorded the highest proportion of 9.0 percent since 2015. Group D recorded the lowest proportion since the market started, of 1.0 percent.

Overall, the reserve provider group's effectiveness improved in 2022. The proportion of reserve providers in the more responsive Groups A and B improved from 89.3 to 90.0 percent, while the proportion of reserve providers in the less responsive Groups C, D and E contracted from 10.7 to 10.0 percent. The sole reserve provider in Group E in 2021 shifted into a more responsive group in 2022.

All contingency reserve providers were classified in Group A.

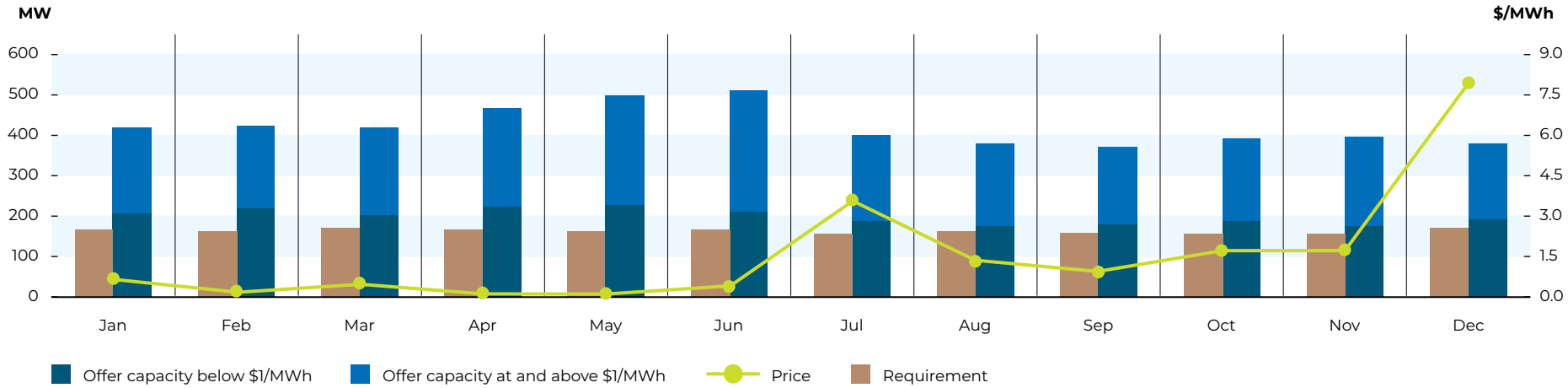
Reserve Provider Group Effectiveness for Primary Reserve Class (Aggregate) 2018–2022



Statistics exclude IL providers.

ANCILLARY MARKETS

Monthly Primary Reserve Price, Requirement and Supply 2022



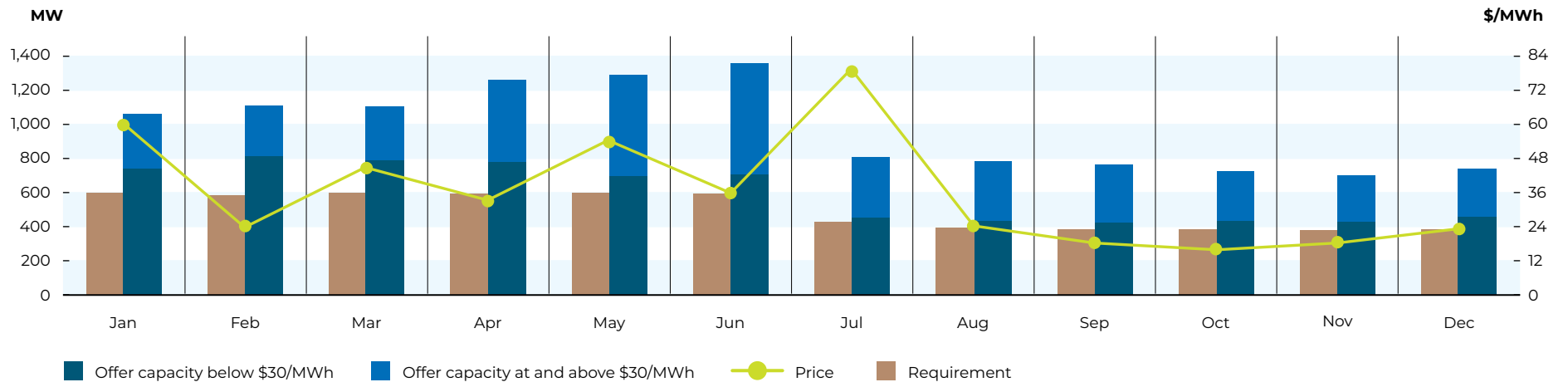
Increased occurrences of primary reserve shortfalls

The annual average primary reserve price increased from $1.13/MWh in 2021 to $1.64/MWh in 2022. The highest monthly average price was $7.91/MWh in December, followed by $3.59/MWh in July. The lowest monthly average of $0.13/MWh was observed in May. The price spike in December was attributed to seven periods of primary reserve shortfall arising from tight market supply conditions. In contrast, there was no primary reserve shortfall in 2021.

The annual average primary reserve requirement fell 5.8 percent to 163MW, while the annual primary reserve offers dropped 17.0 percent to 424MW. Similar to 2021, there were no intertie disconnections and adjustments to its RAF in 2022. Its RAF remained at 1.0. On a monthly basis, the primary reserve requirement ranged between 154MW and 171MW. The primary reserve offers grew from 422MW in January to 512MW in June, dropped to 402MW in July, and remained below 400MW thereafter. The proportion of primary reserve offers below $1.00/MWh was below 50.0 percent in all months except February and December.

ANCILLARY MARKETS

Monthly Contingency Reserve Price, Requirement and Supply 2022



Contingency reserve price surges on record number of shortfalls

The annual average contingency reserve price more than doubled from $14.43/MWh in 2021 to $36.11/MWh in 2022. The highest monthly average price of $79.03/MWh was observed in July while the lowest was registered in October at $15.88/MWh.

The annual average contingency reserve requirement declined 18.0 percent to 496MW, while the annual average contingency reserve offers fell 24.4 percent to 978MW. On a monthly basis, the contingency reserve requirement hovered around 600MW between January and June, and fell to between 381MW and 433MW for the rest of the year when its RAF was lowered from 1.5 to 1.0 with effect from 8 July Period 1. The lowest contingency reserve requirement of 381MW was observed in November, while the highest was seen in March at 605MW. Similar to primary reserve offer changes, the contingency reserve offers grew gradually from 1,066MW in January to 1,365MW in June, before falling sharply to 810MW in July in line with the lower requirement. The proportion of contingency reserve offers below $30.00/MWh remained above 50.0 percent in all months.

Amidst the tight supply cushion in 2022, the total number of periods with contingency reserve shortfall jumped to a historic high of 680, which was more than 10 times that of 2021. There were 155 periods in July that recorded a contingency reserve shortfall, which was the highest number in a month compared to the other months in 2022. This was in line with July's monthly average price being the highest monthly level in the year.

ANCILLARY MARKETS

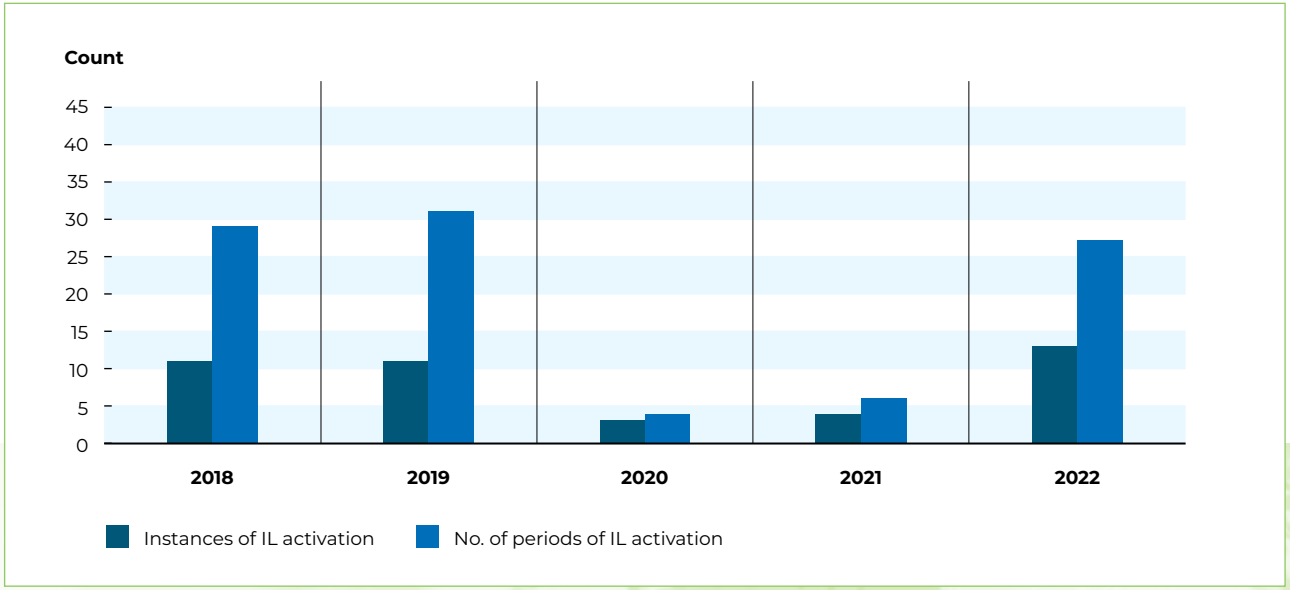
More frequent and longer duration of IL activation

As at 31 December 2022, there was no registered capacity for interruptible load (IL) for primary reserve. For contingency reserve, the total IL registered capacity increased from 9.9MW to 24.9MW.

In 2022, the number of IL activations for contingency reserve increased from four to 13, while the total number of periods when IL was activated for contingency reserve increased from six to 27. The resulting proportion of periods of IL activation against the total number of periods in a year increased from 0.03 percent in 2021 to 0.2 percent in 2022. The longest continuous stretch of IL activation in 2022 lasted five periods (on 27 July), up from two periods in 2021 (each on 14 October and 7 November).

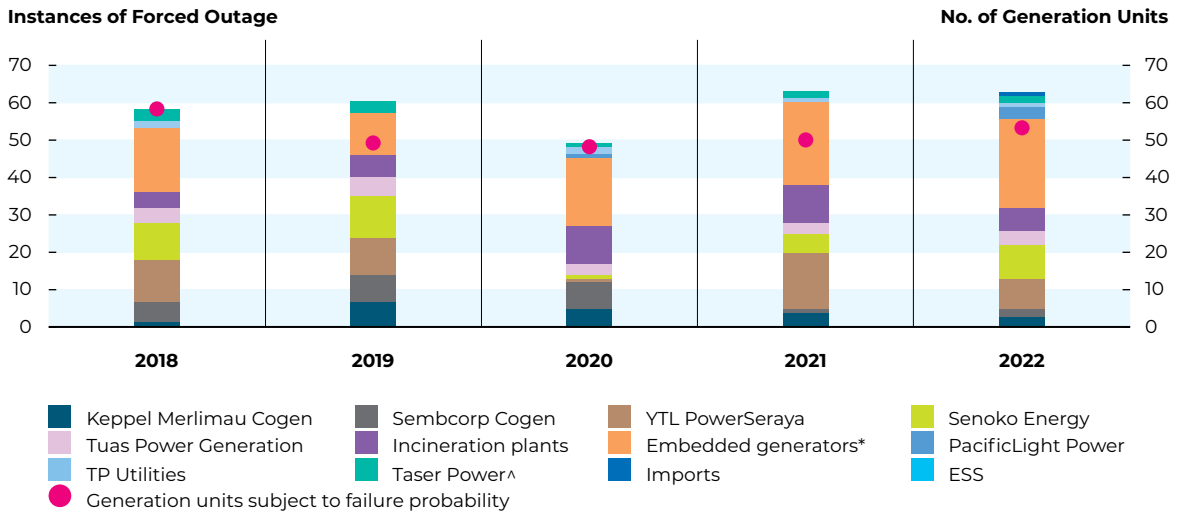
All instances of IL activation occurred from July onwards, except one instance in January. Compared to the first half of the year, the contingency reserve offers from IL units in the second half of the year were higher amidst lower overall contingency reserve offers in excess of its requirement.

Annual Interruptible Load (IL) Activations for Contingency Reserve Market 2018–2022



ANCILLARY MARKETS

Annual Forced Outages by Generation Companies 2018–2022



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.
^ Formerly Tuaspring.

Total number of forced outages remains unchanged

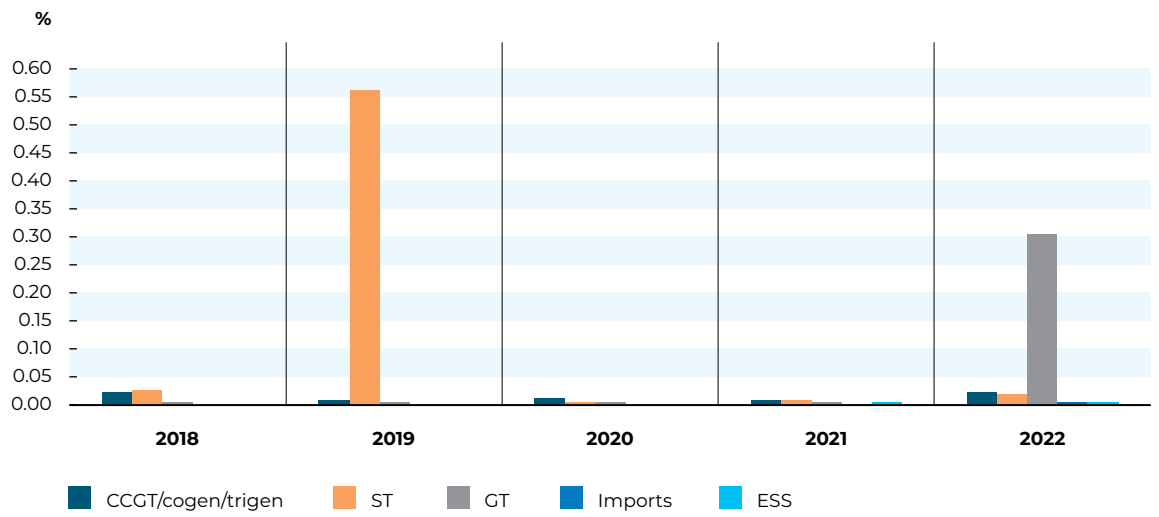
The total number of forced outages remained at 63 in 2022. With the exception of incineration plants and two generation companies, the rest either experienced the same number or an increase in the number of forced outages. An import facility entered the market in 2022 and experienced one instance of forced outage.

With the addition of import facility and energy storage systems in 2022, the number of generation units subject to failure probability[20] increased to 53 in 2022.

20 The number of generation units subject to failure probability including energy storage systems was 51 in 2021. The first import facility entered the market in June 2022.

ANCILLARY MARKETS

Average Failure Probability by Year 2018–2022



Overall reliability of generation facilities 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.

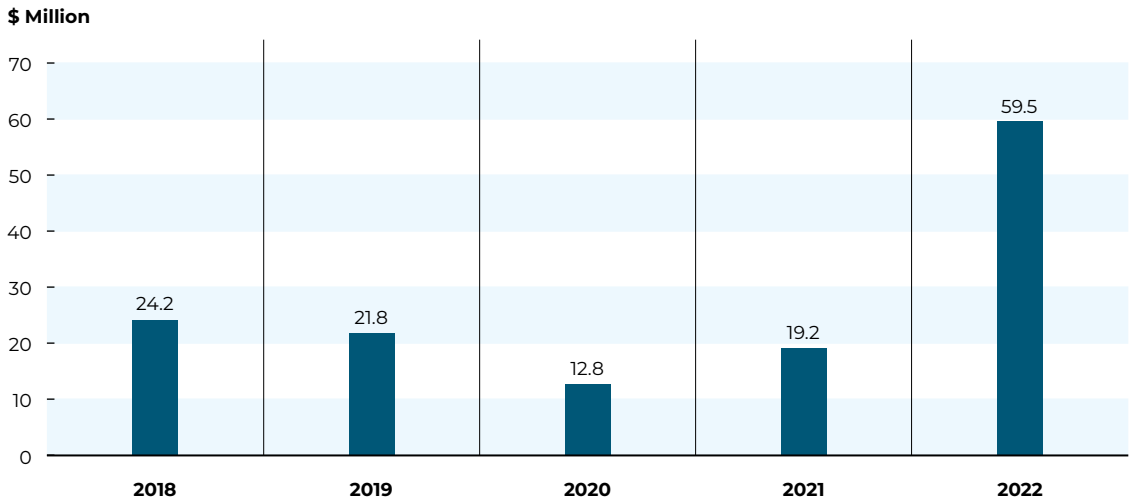
In short, failure probability is a measure of the reliability of the generation facility. The lower the failure probability, the higher the reliability of the generation facility.

The average failure probabilities of CCGT/cogen/trigen, ST and GT facilities were 0.023, 0.019 and 0.301 percent respectively in 2022, which were higher than those in 2021. The average failure probability of energy storage systems remained unchanged at 0.001 percent from 2021 to 2022. Import facility entered the market in 2022 with an average failure probability of 0.001 percent.

The performance of CCGT/cogen/trigen facilities was aligned with their increased occurrences of forced outages. On the other hand, despite fewer forced outages of ST and GT facilities, their average failure probabilities increased due to sharp increases in failure probabilities of a few of them. Overall, the average failure probabilities were higher for 26 facilities and lower for 15 facilities.

ANCILLARY MARKETS

Annual Regulation Payment 2018–2022



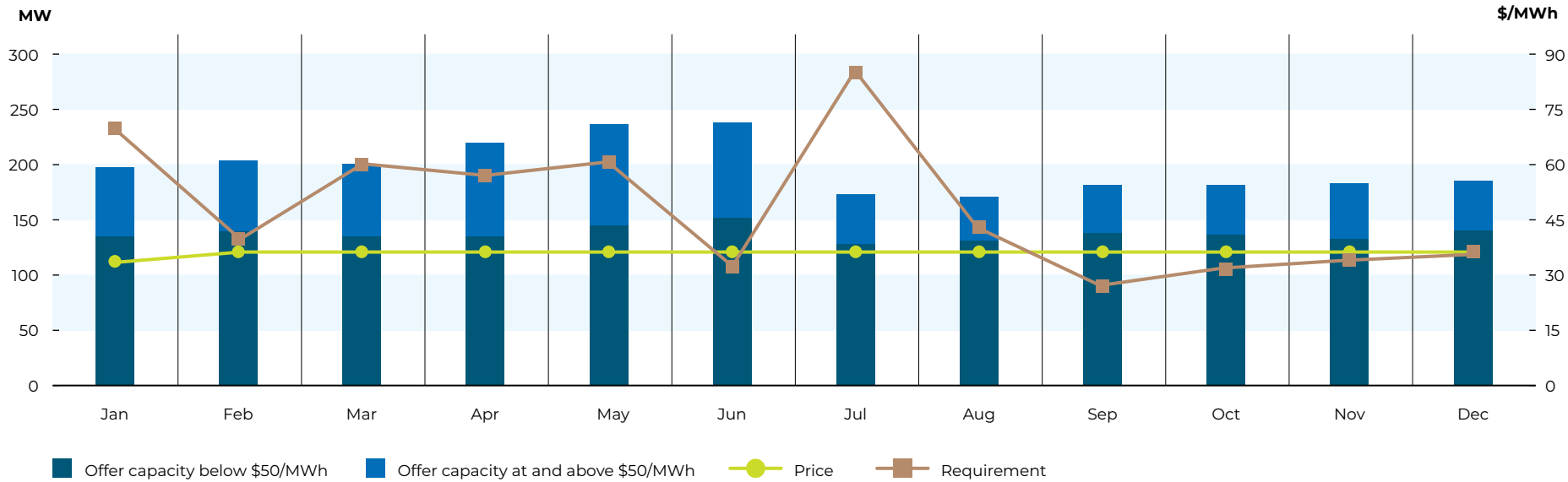
Regulation payment rises to 12-year peak

Regulation payment more than tripled from $19.2 million in 2021 to $59.5 million in 2022. This was in line with the regulation requirement increasing from 114MW to 120MW with effect from 1 February 2022, and the regulation price nearly tripling from $16.45/MWh in 2021 to $48.20/MWh in 2022.

Compared to 2021, the regulation payment increased for all months in the year, crossing the $2.0 million mark every month. The largest increase was in July, at $7.0 million, which registered the highest monthly regulation payment of $8.9 million in 2022. The lowest monthly regulation payment was $2.9 million in September.

ANCILLARY MARKETS

Monthly Regulation Price, Requirement and Supply 2022



More volatile regulation prices amid more frequent shortfalls

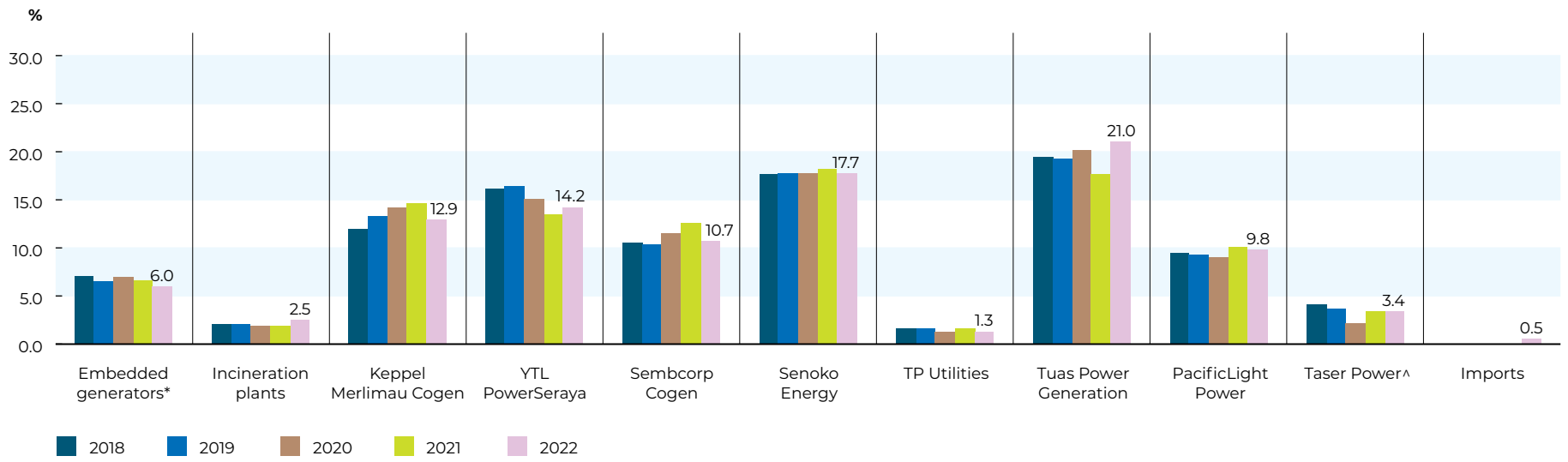
In 2022, the annual average regulation price almost tripled from $16.45/MWh in 2021 to $48.20/MWh in 2022. Similar to the contingency reserve price, the highest monthly average price was $85.04/MWh in July. The lowest monthly average of $27.44/MWh was observed in September. Compared to 2021, regulation prices became more volatile in 2022. In 2021, the lowest monthly regulation price was $5.19/MWh in January while the highest was $33.60/MWh in November – a spread of $28.41/MWh. In 2022, this spread widened to $57.60/MWh. The standard deviation continued to increase from $9.70/MWh in 2021 to $17.96 /MWh in 2022.

The annual regulation requirement increased from 114MW to 120MW with effect from 1 February 2022. The annual average regulation offers declined 8.4 percent to 197MW. On a monthly basis, the regulation offers mirrored the reserve offer changes, increasing from 197MW in January to 239MW in June and falling below 200MW from July onwards. The proportion of regulation offers below $50.00/MWh ranged between 61.1 percent and 68.8 percent in the first half of the year, while ranging between 72.8 percent and 76.8 percent in the second half.

Similar to the contingency reserve shortfall, the total number of periods with regulation shortfall in 2022 stood at a record high of 112. This was 16 times of the total number of such periods in 2021. July registered the highest number of such periods at 76, which corresponded with its average price being the highest monthly level in the year.

COMPETITION IN THE GENERATION AND RETAIL MARKETS

Annual Market Share by Generation Company 2018–2022 (Based on Scheduled Generation)



* Embedded generators exclude TP Utilities.
^ Formerly Tuaspring.

Market shares of most major generation companies drop

In 2022, YTL PowerSeraya replaced Keppel Merlimau Cogen to join Tuas Power Generation and Senoko Energy as the top three generation companies with the biggest annual market share. The combined market share of these three leading generation companies grew 2.4 percentage points to 52.9 percent.

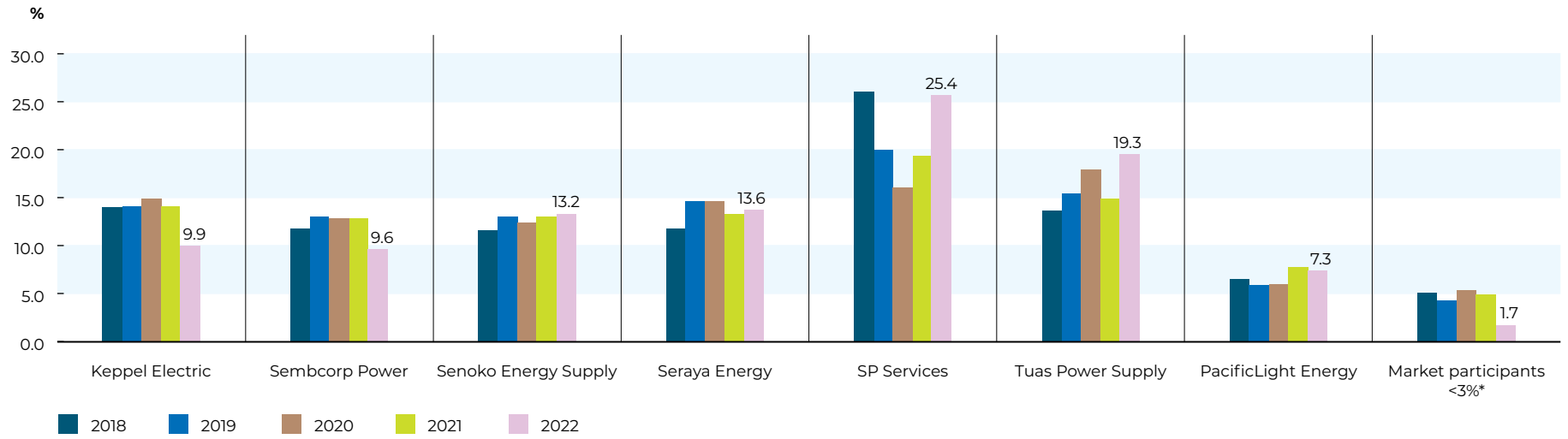
The first import facility entered the market this year, averaging 0.5 percent market share for the year.

Among the generation companies which experienced a decline in market share, Sembcorp Cogen's market share contracted the most, by 1.8 percentage points. This was followed by Keppel Merlimau Cogen's market share decreasing by 1.7 percentage points. Senoko Energy's and EGs' market shares shrank 0.5 and 0.6 percentage point respectively, while those of PacificLight Power and TP Utilities dropped by 0.2 percentage point each.

For the remaining generation companies, Tuas Power Generation led the gain at 3.3 percentage points. YTL PowerSeraya's market share expanded 0.7 percentage point, while those of the incineration plants increased 0.5 percentage point. The market share of Taser Power (formerly Tuaspring) remained at 3.4 percent.

COMPETITION IN THE GENERATION AND RETAIL MARKETS

Annual Market Share of Market Support Services Licensee and Retailers 2018–2022 (Based on Withdrawal Energy Quantity)



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

Market shares of most retailers fall

In the Open Electricity Market (OEM), the consumption of residential consumers who have switched from SP Services to retailers and who selected the Load Profiling (LP) metering option (LP consumers) is included as part of the system residual load which will be wholly settled by SP Services in the NEMS. SP Services will bilaterally settle 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 2022, SP Services maintained the largest market share at 25.4 percent. This was a 6.1 percentage point gain from 2021 and was its largest market share since 2019. Among the larger retailers[21], Senoko Energy Supply overtook Keppel Electric, joining Seraya Energy and Tuas Power Supply in the top three positions.

Apart from SP Services, Senoko Energy Supply, Seraya Energy and Tuas Power Supply were the only other retailers which saw their market share expand by 0.3, 0.3 and 4.4 percentage points respectively. Keppel Electric's market share fell the most, by 4.1 percentage points, followed by Sembcorp Power's market share dropping by 3.3 percentage points. PacificLight Energy's market share contracted 0.4 percentage point.

In the 'Market participants <3%' category, Hyflux Energy and Ohm Energy were deregistered in April and in December respectively[22]. The market share of this category shrank 3.2 percentage points to 1.7 percent. This category comprises retailers with a market share of less than 3.0 percent each.

21 Excludes consumers who purchase from SP Services.
22 Registration of Hyflux Energy and Ohm Energy expired by the end of trading date 26 April and 30 November 2022 respectively.

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 2022

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 2022.

A notice of default 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 2022, EMC issued four default notices[23], which were remedied on the following business day.

Automatic Financial Penalty Scheme (AFPS) and Minimum Stable Load (MSL) Compensation Scheme — 1 January to 31 December 2022

The 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 introduced in April 2016, and now applies to all LRFs with restricted energy bids that deviate from their dispatch schedules. In 2022, there were 95 periods when the AFPS kicked in, including ten periods for deviating LRFs. The total penalty collected was $1,028,132.45. The penalty collected was returned to the market via the monthly energy uplift charges.

The 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 2022, $25,017.10 was paid out for a total of six periods under the MSL compensation scheme. The amount paid out was funded by the market via the monthly energy uplift charges.

23 A default notice is issued to a defaulting market participant up till the market participant is suspended.

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 2022 to 31 March 2023, 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 $10.29 million for the period from 1 April 2022 to 31 March 2023. The capability was sourced from YTL PowerSeraya, Senoko Energy, Tuas Power Generation, and Keppel Merlimau Cogen.

Contracted Ancillary Services — 1 April 2022 to 31 March 2023

Contract Period	Cost of Ancillary Services (including GST)	Total MW Contracted
1 April 2022 to 31 March 2023	$10,291,023.74	88.848

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 2022 to 30 June 2023

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 6th token onwards per MP) $110 per token (replacement fee for lost or damaged token)
EMC Fee per MWh ($/MWh)	0.3589

PSO Fixed Fees – 1 July 2022 to 30 June 2023

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

PSO Net Fees – 1 April 2022 to 31 March 2023

PSO Net Fees ($'000)	29,493


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.

balance vesting quantity
With the start of the Liquefied Natural Gas (LNG) Vesting Scheme in the third quarter of 2013, a certain percentage of the total allocated vesting quantity is pegged to LNG. The remaining percentage pegged to piped natural gas is known as the balance vesting quantity.

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
With the start of the Liquefied Natural Gas (LNG) Vesting Scheme in the third quarter of 2013, 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 an electricity licence issued by the Energy Market Authority (EMA) and has been registered with Energy Market Company (EMC) as a market participant to trade in the wholesale electricity market.

GLOSSARY

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

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 as 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.

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 after matching off demand.

uniform Singapore energy price (USEP)
The weighted-average of the nodal prices at all off-take nodes.

vesting contract
A regulatory instrument imposed on some generators by the Energy Market Authority (EMA), with the objective of mitigating the potential exercise of market power when the supply side of the industry is concentrated among a small number of generators. A vesting contract requires these generators to sell a specified quantity of electricity (vesting contract level) at a specified price (vesting contract hedge price).

vesting contract hedge price (VCHP)
This is calculated by the Market Support Services Licensee (MSSL), SP Services, every three months. It is determined using the long-run marginal cost of the most efficient generation technology in the Singapore power system, i.e., the combined-cycle gas turbine. Energy Market Company's (EMC) settlement system uses the VCHP to settle the vesting quantity between the MSSL and the generation companies. With the introduction of Liquefied Natural Gas (LNG) into the generation mix, the VCHP has been replaced by 'LNG vesting price' and 'balance vesting price' from July 2013.

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.

Notice and Disclaimer

This publication is meant only for general information and nothing in it may be construed as advice. Whilst EMC has taken reasonable care in the preparation of this publication, EMC does not warrant its suitability for any purpose. You should always consult your professional advisers before making any decision.

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