National Electricity Market of Singapore

MARKET REPORT 2021

CONTENTS

2021 AT A GLANCE

Total registered capacity of generators expanded **2.6%** ↑

13 new facilities were added to the market ↑

1 new generator and **3** new wholesale market traders joined the market

Number of periods with Demand Response curtailment increased **1,391%** ↑

Electricity consumption rose **5.7%** ↑

Number of forced outages increased **28.6%** ↑

Generation supply grew **2.8%** ↑

Annual value of products traded jumped **200.3%** ↑

Uniform Singapore Energy Price (USEP) surged **180.4%** ↑

Combined market share of top 3 generation companies fell to **50.5%** ↓

Market share of SP Services grew to **19.3%** ↑

ENERGY MARKET COMPANY:

LETTER FROM THE CHAIRMAN

Dear Industry Members

2021 was a year of recovery. As the world continued to navigate through the impact of Covid-19 and the virus variants, Singapore showed signs of recovery as more than 80 percent of our population were vaccinated and we prepared for Covid-19 to become endemic. GDP grew by 7.6 percent year-on-year (YOY) as economic activities picked up in 2021, driving a 5.7 percent YOY jump in electricity consumption, which hit an unprecedented 53.6 terawatt hour.

2021 in Review

While the global economy showed signs of recovery, it was unfortunately challenged by supply chain shocks and gas shortages leading to high gas and electricity prices. Singapore was no exception.

The National Electricity Market of Singapore (NEMS) saw record highs in 2021 amidst the global energy crisis. Increased demand for electricity coupled with a tight global gas market and the disruption of piped natural gas supply from Indonesia, led to sustained volatility in the Singapore Wholesale Electricity Market in the second half of the year.

The daily Uniform Singapore Energy Price (USEP) hit a record high of $2,058.85 per megawatt hour (MWh) on 1 December, and the highest monthly average USEP since the market started in 2003 was recorded in October at $491.24/MWh. The average USEP for the year was $196.33/MWh – the third highest annual average since the market started.

The combination of price spikes and stronger demand resulted in the annual value of products traded in the wholesale market to hit a record high of more than $11.8 billion in 2021.

There was an increase in demand response (DR) activations from 23 to 343 periods totalling 8,245 megawatts (MW) of curtailed load compared to 646MW in 2020, a surge of more than 12-fold. The increase in DR activation demonstrated that DR remains an important market mechanism in the NEMS to reduce electricity demand at times of high USEP.

For the consumers, DR allows them to manage their electricity consumption in response to market conditions. As more DR participation can contribute towards price stability in tight supply situations, EMC will review current DR guidelines and work with the Energy Market Authority (EMA) to promote DR participation in the NEMS.

The unprecedented price volatility and market uncertainty in the second half of 2021 resulted in the exit of four independent retailers. Their existing customers were transferred back to SP Services, which led to SP Services reclaiming the largest market share among retailers.

Despite the exits, the number of default notices fell from 2020's 78 default notices. EMC issued 19 default notices in 2021, and stemming from these, 31 first default levy notices were issued. 17 of these were remedied from their existing credit support while 14 first default levy notices were recovered from the market.

Learning from the events of default in 2021, EMC will work with the industry and the Rules Change Panel to review and strengthen the prudential requirements in the NEMS while holding in balance any cost increase to market participants. We are committed to preserving the market's resilience and safeguarding its financial integrity.

LETTER FROM THE CHAIRMAN

Many consumers were understandably concerned when their retailers exited the market while electricity prices surged to a record high in 2021. EMC is committed to working with the EMA and industry stakeholders to implement short-term solutions to stabilise the market and ride through the global energy crisis.

I am encouraged that there continued to be new investments in the NEMS, with 13 new facilities and four new market participants entering the market. We also welcomed the NEMS' first energy storage system (ESS) into the market. ESS will help to manage solar intermittency and enhance grid resilience from the energy generated by Singapore's solar systems.

EMC's 20th Anniversary

2021 also marked the 20th anniversary of EMC's incorporation. In 2001, we transitioned from the Singapore Electricity Pool to the existing NEMS. We started off with a team of 14 serving ten market participants (MPs) when the NEMS wholesale market began trading in 2003. By the end of 2021, EMC, along with the wholesale market, had grown to a team of more than 70 staff serving 49 MPs, with 114 generation facilities and five load facilities.

I would like to thank all EMC colleagues, past and present, for their commitment and dedication, and our MPs and stakeholders for their unwavering support over the last 20 years. You are all part of the success that we enjoy today. Let us continue to work together to ensure that the market is resilient and competitive for many more years to come.

Creating a Sustainable Future

Singapore is ready to bounce back from the challenges brought by Covid-19. Electricity demand is projected to grow between 2.8 percent and 3.2 percent YOY over the next ten years, attributable to the growth of electricity-intensive activities such as new data centres and wider adoption of electric vehicles.

Intermittent generation sources such as the recently completed Tengeh Floating Solar Farm are leading the way in providing cleaner energy sources as Singapore aims to transform into a greener and more sustainable city by 2030.

To this end, Singapore will also begin trials to import up to four gigawatts of low-carbon electricity by 2035. These will further efforts to leverage on the ASEAN Power Grid infrastructure to support regional decarbonisation efforts. EMC continues to support the EMA amid the energy transition and will work with industry stakeholders to meet the needs of the industry.

Even as Covid-19 still looms large, I am confident that with the cooperation of our industry partners in Singapore and across the region, we will establish the NEMS as an internationally respected wholesale electricity market and also solidify Singapore's sustainable future for generations to come.

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
2012	NEMS completed ten successful years of trading
2013	Singapore's Liquefied Natural Gas (LNG) terminal started commercial operations LNG vesting contract introduced
2015	Electricity futures trading commenced
2016	Demand Response programme introduced
2018	Open Electricity Market (OEM) launched and rolled out in stages
2019	Rollout of OEM across Singapore completed Vesting contract regime rolled back to LNG vesting contract level

MARKET OVERVIEW:

INDUSTRY STRUCTURE

Participants and Service Providers in the NEMS

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

Wholesale Market Traders			
Air Liquide Singapore	LYS Genco Beta	Singapore LNG Corporation	Sunseap Leasing Beta
JE Green Solutions	MSD International GmbH	Sun Electric Energy Assets*	Sunseap VPower*
Enel X Singapore	Public Utilities Board	Sunseap Energy Ventures*	Terrenus Energy
Green Power Asia	Singapore District Cooling	Sunseap Leasing	Terrenus Energy SL2*

Retailers			
Best Electricity Supply	Hyflux Energy	PacificLight Energy	Tuas Power Supply
Bioenergy	I Switch*	Sembcorp Power	UGS Energy*
Cleantech Solar Singapore Assets	Just Electric	Senoko Energy Supply	Union Power
Diamond Electric*	Keppel Electric	Seraya Energy	
Flo Energy Singapore	MyElectricity*	SilverCloud Energy*	
GreenCity Energy	Ohm Energy	Sunseap Energy	

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 2021:*
- *Sunseap Energy Ventures, Sunseap VPower, Sembcorp Floating Solar Singapore, and Terrenus Energy SL2 joined the market in April, April, May and August respectively.*
- *MyElectricity, I Switch and UGS Energy withdrew from the market in September, December and December respectively.*
- *Sun Electric Energy Assets and SilverCloud Energy's registrations as a market participant were terminated in March and December respectively by the Market Surveillance and Compliance Panel.*
- *Sembcorp Solar Singapore, previously a wholesale market trader, obtained a generation licence with effect from October.*
- *Diamond Energy Merchants was renamed Diamond Electric.*

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 2021

In 2021, the NEMS welcomed one new generator (Sembcorp Floating Solar Singapore) and three new wholesale market traders (Sunseap Energy Ventures, Sunseap VPower and Terrenus Energy SL2). This brought the total number of market participants (MPs) in the NEMS to 49 at the end of 2021, comprising 17 generators, 15 wholesale market traders and 17 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 OVERVIEW:

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

This process is run half-hourly to determine the:

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

Energy, Reserve and Regulation Products

	Description	Purchaser	Seller
Energy	Generated electricity	Retailers	Generators
Reserve	Stand-by generation capacity or interruptible loads (ILs) 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

MARKET FEATURES

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 109 injection nodes, and the prices at up to 887 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.

EMC uses metered demand and generation from the MSSL and market prices to settle market transactions daily. 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.

1 *Numbers of injection and withdrawal nodes are as at 31 December 2021.*

MARKET GOVERNANCE

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.

MARKET GOVERNANCE:

LETTER FROM THE CHAIR, RULES CHANGE PANEL

Dear Industry Members

2021 was a challenging year for power systems and electricity markets around the world. After severe weather conditions led to power emergencies in Texas and California in February and July, European countries battled severe gas shortages amid rising electricity demand as they headed into a very cold winter. Singapore, which relies on imported natural gas for over 90 percent of its electricity generation, was not immune to this global energy crisis. In the second half of 2021, we saw highly volatile wholesale electricity price movements due to piped natural gas supply disruptions. As a result, several electricity retailers exited the business.

Operating amidst a gas supply crunch, the fine-tuning of market mechanisms to ensure both security and adequacy of Singapore's power supply became a critical concern for the Rules Change Panel (RCP). To improve the pricing mechanism to correctly recognise the value of standby capability in shortfall situations, the Panel scrutinised the parameter settings of the constraint violation penalty to mitigate reserve shortfalls in the market. Panel members debated intensely the trade-offs between higher costs to consumers and a more reliable supply. While the Panel agreed that raising the level of constraint violation penalties would improve reliability by securing sufficient reserves from more costly sources, it has decided to continue to explore more cost-effective ways to ensure supply adequacy in the long run.

The exit of several electricity retailers following wholesale price volatility also triggered discussion on the market's readiness to manage market participant (MP) defaults. The Panel investigated the introduction of safeguards to deter late payment by MPs and reviewed the frameworks under which Energy Market Company (EMC) and the Market Surveillance and Compliance Panel handle some types of default. Rule changes were passed to ensure that appropriate remedies and reasonable actions can be taken against each type of default in a timely manner. I believe this will mitigate the negative impact of market defaults and strengthen stakeholders' confidence in the financial integrity of the market.

The Panel also did not overlook the operational efficiency of the system and market operators. The RCP unanimously supported two proposals to (1) facilitate EMC's collection of payments of annual fees; and (2) improve the modelling of generation settlement facilities and reduce the number of price revisions. These will lighten the operational burden on EMC and the Power System Operator, releasing resources for more critical tasks.

Singapore's power sector is expected to face more changes and uncertainties in the coming years, as the country has embarked on its energy transition journey. The rules change process will undoubtedly continue to play a critical role as the NEMS evolves to adapt to these changes. I am confident that with close collaboration between market participants, service providers, the RCP, the EMC Board, and the Energy Market Authority, we can help steer the industry towards a dynamic and sustainable energy future for Singapore.

Toh Seong Wah
Chair
Rules Change Panel

Rule Changes Supported by the Rules Change Panel

As part of the continual efforts by the Rules Change Panel (RCP) to guide the evolution of the wholesale electricity market, the following rule changes were discussed and approved.

Review of Allowable Remedies for Events of Default

Previously, EMC would issue a default notice to the MP when an event of default occurs. This notice specifies the alleged event of default and the MP is given one business day (BD) to rectify the default event.

In practice, however, it is not realistic to expect a MP to remedy certain types of default within one BD, and/or for EMC to take the actions required under the Market Rules. EMC thus undertook a review to ensure that prescribed remedies and actions are appropriate for each type of default.

The following rule changes were proposed:

1) To distinguish events of default that are related to credit support providers of MPs from the events of default listed in the Market Rules.

   It was proposed that the handling of defaults related to MPs' credit support providers be aligned with the current Market Rules' handling of invalid credit support: an MP is given two BDs to replace its credit support when it becomes invalid.

   If the MP fails to comply, it would have incurred an event of default. EMC will then refer the case to the MSCP for appropriate action, which includes the possibility of issuing a suspension order on the MP.

2) For an event of default arising from failure to meet material registration requirements (e.g., bank account and IT system requirements), it is not practical to expect the MP to rectify the default within one BD. Given that such defaults do not compromise the financial integrity of the wholesale market, it was proposed that EMC be given discretion to determine how swiftly the MP must remedy the default (up to a maximum of five BDs).

3) To clarify the actions that EMC may take in response to different defaults.

   - For defaults such that (a) it is not practical for the MP to remedy within a short period of time (e.g., if it becomes unlawful for the MP to comply with any of its obligations under the Market Rules), or (b) it is not appropriate for EMC to specify the remedy (e.g., defaults due to non-compliance with the MSCP's order), it was proposed that EMC issue a default notice to the MP and refer the case to the MSCP directly for appropriate action (which includes the possibility of issuing a suspension order).
   - For defaults that do not affect the financial integrity of the market, it was proposed that EMC be given the flexibility not to claim on the MP's credit support.

These proposed rule changes were supported by the RCP and approved by the EMA. They took effect on 7 December 2021.

Mode of Payment for Annual Market Participant and PSO Fees

EMC collects fees from applicable MPs, MSSL, and other persons to recover the EMC's and the PSO's administrative costs. There are two components to these fees. The component of interest involves a fixed amount collected annually, hereafter referred to as Annual Fees.

Current market rules do not specify any payment methods for the Annual Fees. However, a lack of clarity over the payment method can hinder operations. Therefore, a rule change was proposed to clarify that the primary payment method for the Annual Fees would be via electronic funds transfer, a method most market players are familiar with. It was also proposed that the EMC retain needed flexibility to provide for valid exceptional cases.

This rule change was supported by the RCP and approved by the EMA. It took effect on 4 March 2022.

Designation of Default Bus of Generation Settlement Facilities

When a generation settlement facility (GSF) and both of its default buses are disconnected, the MCE produces anomalous ex-ante prices that necessitate ex-post MCE re-runs with redesignations of default buses of the GSF. EMC assessed that when network status information leading to GSFs being islanded can be pre-empted, such re-runs could be eliminated by allowing the PSO to designate the main and alternate default buses of the GSFs to be in different substations such that at least one of the substations are connected.

The proposal improves price certainty and saves costs for the market, especially if the substation to which the main default bus is connected is on maintenance for multiple consecutive periods.

This rule change was supported by the RCP and approved by the EMA. It took effect on 4 March 2022.

Other Rule Changes Considered by the RCP

Providing Real-Time Estimates of Reserve Responsibility Share for Each Generation Registered Facility

Currently, reserve costs are allocated to Generation Registered Facilities (GRF). A GRF's share of reserve cost is represented by the Reserve Responsibility Share (RRS). Under the current Market Rules, the RRS is calculated after each Real-Time dispatch period and made available to the MP that owns the GRF (owner-MPs).

A rule change was proposed to calculate a forecasted RRS for each GRF in real-time and to publish the forecasted RRS for each dispatch period of the various market schedules available to the MPs.

While the provision of additional information will improve market transparency and efficiency in the long run, the RCP was concerned that such information may enhance pivotal MPs' ability to exercise market power. On balance, to mitigate market power concerns, the RCP agreed to provide forecasted RRS to relevant owner-MPs instead of publishing all forecasted RRS to all MPs.

This proposal was supported by the RCP. EMC will implement this proposal as a value-added service to MPs.

Deterrence of Late Payment by Market Participants

Currently, MPs are required to make payment by the timelines stipulated under the Market Rules ("MP payment date"). Settlement payment default occurs when a MP fails to make payment to EMC by 5pm on the MP payment date.

The Market Rules allow a MP to remedy a payment default within one BD. However, MPs may thus hold the misconception that payment that is one BD late is acceptable. This may disincentivise MPs from observing the payment date.

Late payment by a MP disrupts EMC's operation and settlement processes, and results in administrative costs incurred by EMC. It was proposed that measures should be taken to deter potential late payments.

After considering stakeholder feedback on deterrent mechanisms, it was concluded that it would be more efficient for EMC to, where appropriate, impose an administrative cost as a form of deterrent for late payment. This is currently provided for under the Market Rules.

The RCP supported no change to the Market Rules and for EMC to impose an administrative cost for late payment by a MP in accordance with existing provisions under the Market Rules.

Review of Constraint Violation Penalties

This proposal aims to refine the constraint violation penalty (CVP) settings for energy, reserve and regulation in the Singapore Wholesale Electricity Market. The proposal was initiated following frequent occurrences of reserve shortfalls, during which the MCE did not fully utilise all available resources to meet energy and reserve requirements.

The current CVP settings reflect the original intent for reserve deficits, in which some reserve requirement is accorded low priority when the overall supply is tight. However, this has caused relatively frequent reserve deficits especially during tight supply situations where the cost of procuring reserve rises above the reserve deficit CVP level.

On consultation with the PSO, it was determined that all reserve and regulation requirements are essential to maintain system reliability and security and should be procured as long as there is sufficient resource available. EMC thus recommended that higher CVP values be applied to ensure that the MCE will activate more costly resources to fully meet essential requirements. The RCP supported this proposal. However, the EMA assessed that the potential cost to consumers significantly outweighs the potential benefit to the system and did not approve the proposal.

EMC further proposed that an Operating Reserve Demand Curve (ORDC) be considered for the MCE to procure additional reserve if its reliability value so justifies. While the implementation of an ORDC would add to the complexity of reserve procurement and cost allocation, it could potentially improve market efficiency by procuring reserves at a more optimal level. The RCP has supported further study by the EMC of this proposal as a possible long-term solution.

MARKET GOVERNANCE:

LETTER FROM THE DISPUTE RESOLUTION COUNSELLOR

Dear Industry Members,

Dispute Resolution and Compensation Panel

The Dispute Resolution and Compensation Panel (DRCP) was established under the Market Rules to provide dedicated dispute resolution services to the 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, Queen'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[2] 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 Energy Merchants – Muhammad Khairul
6. Enel X Singapore – Daniel Garrett
7. Enel X Singapore – Goh Tong Ye
8. Energy Market Company – Dominic Tan
9. ExxonMobil Asia Pacific – Eric Lim
10. ExxonMobil Asia Pacific – Lim Li Fang
11. Flo Energy Singapore – Matthijs Guichelaar
12. GreenCity Energy – Chilton Loh
13. Green Power Asia – Daniel Ma

2 The DMS contacts were updated as at 31 December 2021. Please refer to EMC's website for the latest list of DMS contacts.

LETTER FROM THE DISPUTE RESOLUTION COUNSELLOR

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

Conclusion

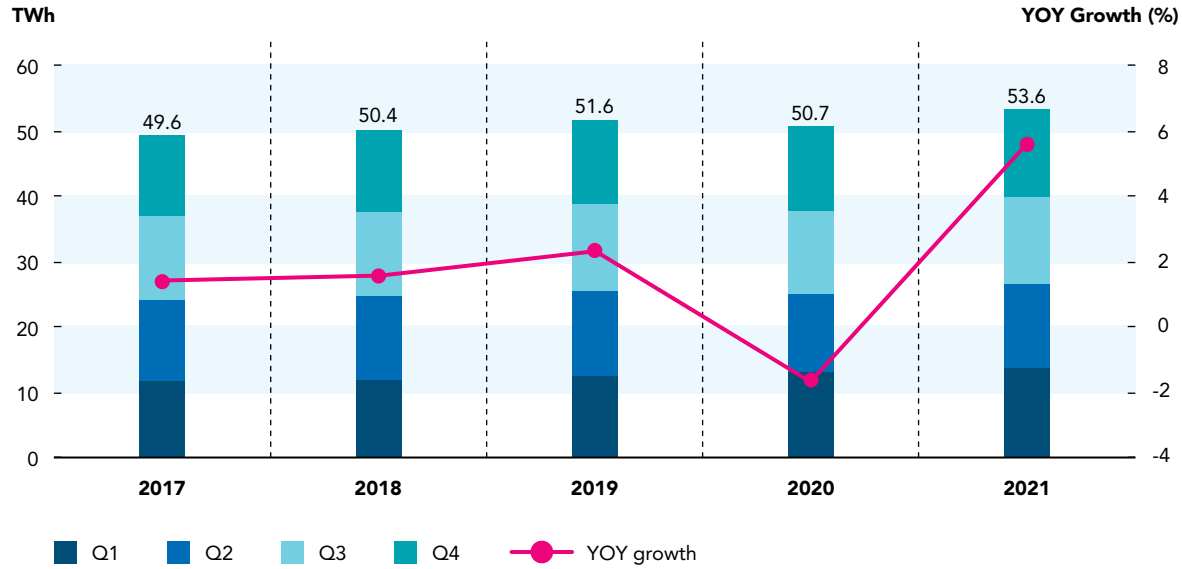
I am happy to report that in 2021, no disputes were filed with this office. I thank the DRCP members and DMS contacts for their contributions and look forward to continuing to support the dispute resolution needs of all NEMS market entities in the coming year.

George Lim
Senior Counsel
Dispute Resolution Counsellor

MARKET PERFORMANCE

OVERVIEW OF THE YEAR

Annual Electricity Consumption 2017–2021



Electricity consumption rebounds in 2021

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

In 2021, Singapore's economy grew 7.6 percent[3] year-on-year (YOY), driving a 5.7 percent YOY increase in electricity consumption. The strong YOY growth was mainly due to the resumption of economic activities from the previous year. Total electricity consumption rose to its highest level since the market started – 53.6 terawatt hour.

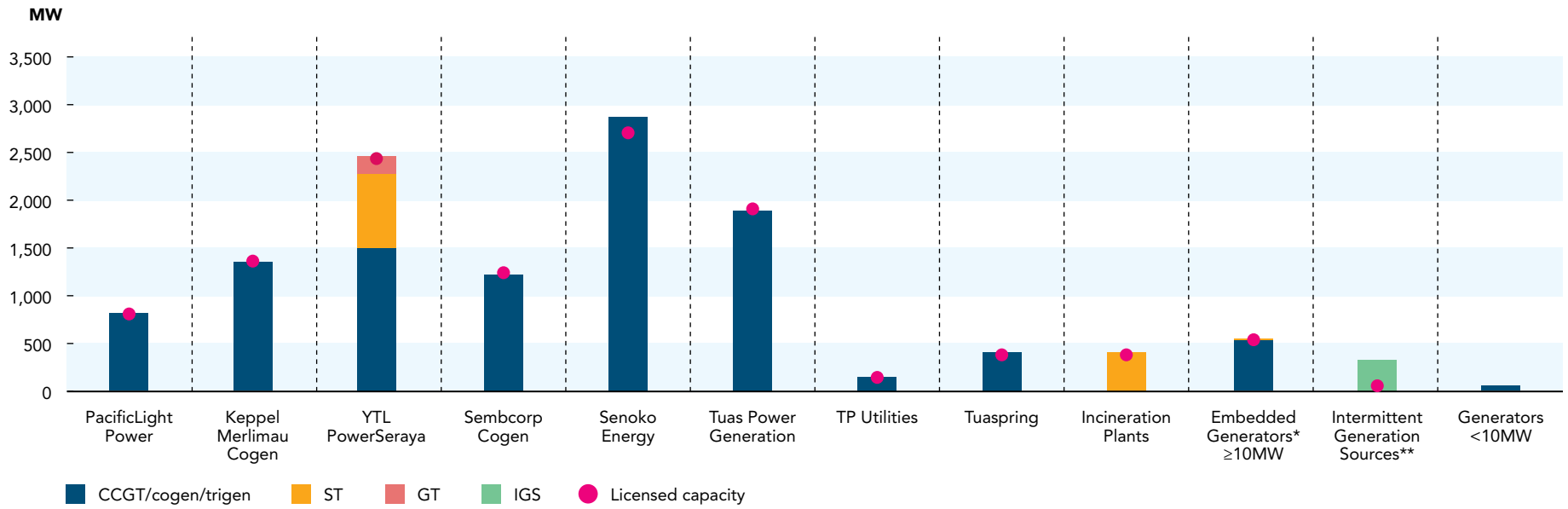
Compared to the corresponding periods in 2020, all quarters in 2021 apart from the first quarter recorded higher electricity consumption. It had been business as usual in Q1 2020 before the impact of Covid-19 hit Singapore, and in Q1 2021, the economy had only just begun reopening following Phase 2 heightened alert measures. The largest increase was in the second quarter, when electricity consumption rose 10.8 percent YOY. The strong growth came off the low base set in Q2 2020 due to the Circuit Breaker (CB) measures implemented to contain the Covid-19 pandemic.

3 *"MTI Maintains 2022 GDP Growth Forecast at "3.0 to 5.0 Per Cent"": Ministry of Trade and Industry, Singapore, 17 February 2022.*

MARKET PERFORMANCE:

OVERVIEW OF THE YEAR

Generation Capacity as at 31 December 2021: Registered Versus Licensed



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

Licensed capacity decreases while registered capacity increases in 2021

Total licensed capacity in the National Electricity Market of Singapore (NEMS) of generators with capacity larger than or equal to 10 megawatts (MW) fell by 110MW to 11,745MW in 2021. The decline came primarily from a downward revision of the licensed capacity of a CCGT/cogen/trigen unit from Senoko Energy.

Total registered capacity of generators rose 2.6 percent to 12,165MW[4] in 2021. This was attributed to the upward revision of a NEIGF unit's capacity and the registration of 11 new generation facilities in the NEMS (see details on pages 24 and 25).

CCGT/cogen/trigen registered capacity made up a smaller proportion – 86.4 percent – of total registered capacity in 2021, a decrease of 2.2 percentage points from 2020.

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

4 *The downward revision of Senoko Energy's CCGT/cogen/trigen unit capacity could not be reflected in the total registered capacity, and excludes battery facility.*

OVERVIEW OF THE YEAR

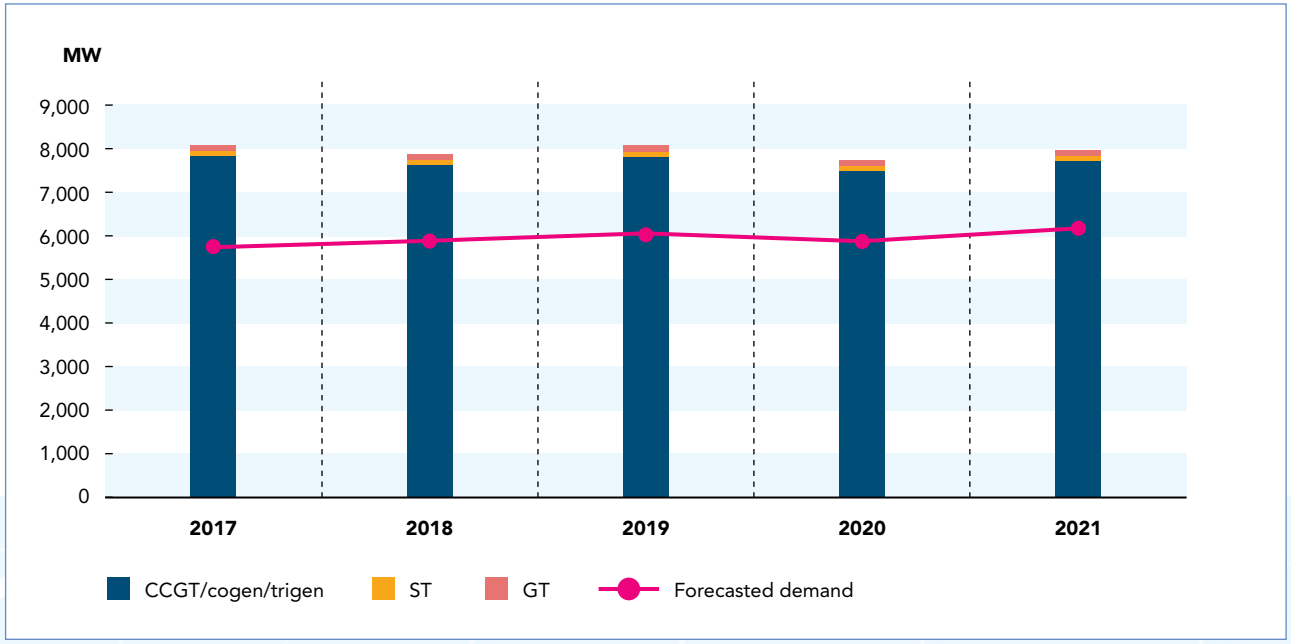
Annual generation supply reverses drop seen in 2020

The annual generation supply increased 2.8 percent to 7,936MW in 2021, rebounding from the seven-year low in 2020.

CCGT/cogen/trigen supply rose to 7,653MW, in line with the improvement in the generation supply. The CCGT/cogen/trigen supply was 23.8 percent above forecasted demand, which was 3.6 percentage points lower than that in 2020. The narrower margin was the result of a smaller increase in CCGT/cogen/trigen supply compared to the rise in forecasted demand.

Both ST and GT supplies increased in 2021. ST and GT supplies were 11.2 percent and 15.7 percent higher, respectively, compared to 2020.

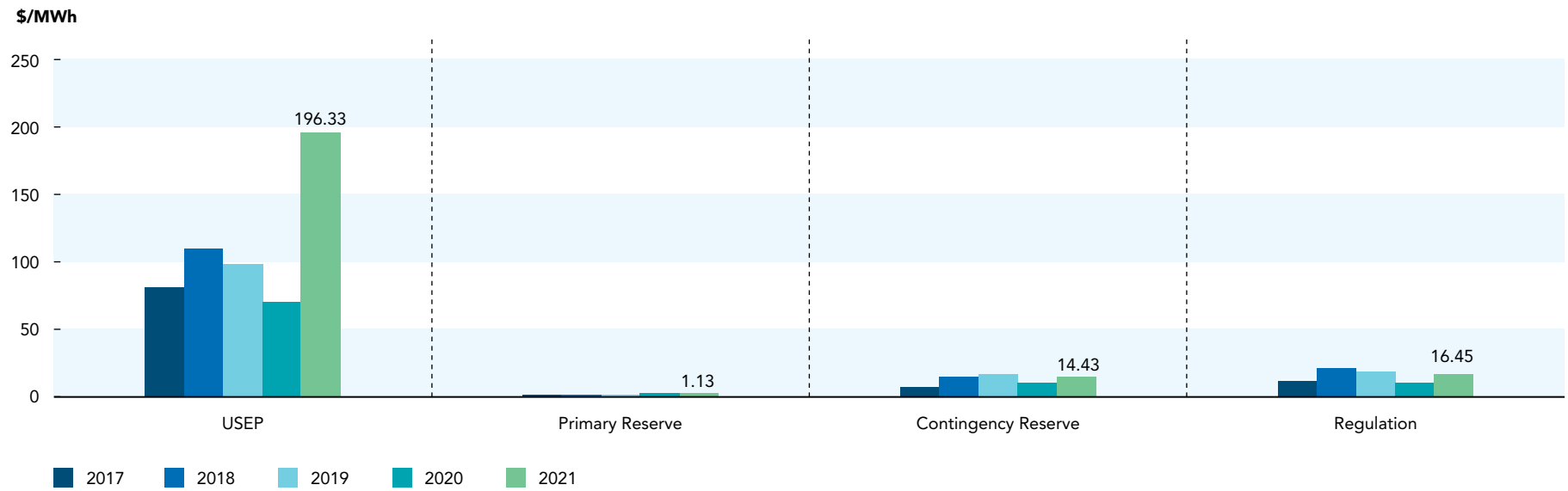
Annual Generation Supply by Plant Type 2017–2021



MARKET PERFORMANCE:

OVERVIEW OF THE YEAR

Annual USEP and Ancillary Prices 2017–2021



Prices of all products rise in 2021

The annual average Uniform Singapore Energy Price (USEP) increased more than two and a half-fold from $70.01 per megawatt hour (MWh) in 2020 to $196.33/MWh in 2021, a nine-year high. The higher USEP was in line with the rise in fuel oil prices due to tightened supply and stronger global demand. In addition, the supply cushion was also lesser in 2021 due to higher forecasted demand, gas curtailment from West Natuna and low landing pressure of gas supplied from South Sumatra[5].

The primary reserve price rose marginally from $1.08/MWh in 2020 to $1.13/MWh in 2021 due to fewer offers in the cheaper tranches. In the absence of adjustments to the Risk Adjustment Factor (RAF)[6] and intertie disconnection, the primary reserve requirement was relatively stable in 2021, ranging between 164MW and 183MW.

The contingency reserve price increased 45.6 percent to $14.43/MWh due to higher requirements and fewer offers in the cheaper tranches.

The regulation price increased 61.0 percent to $16.45/MWh as a result of lesser offer quantities, fewer offers in the cheaper tranches for most months and an increase in the number of periods with shortfall. This increase came in spite of the regulation requirement being revised down from 123MW to 114MW from 1 February 2021.

5 *"Safeguards in Place For Open Electricity Market Consumers": Media release by Energy Market Authority on 16 October 2021.*

6 *There is an RAF for each class of reserve in the NEMS. The RAF is multiplied by the raw reserve requirement to arrive at the final reserve requirement that is cleared by the market clearing engine (MCE). The PSO may amend the RAF for any reserve class temporarily if it foresees power system conditions that may warrant a higher reserve requirement than usual.*

OVERVIEW OF THE YEAR

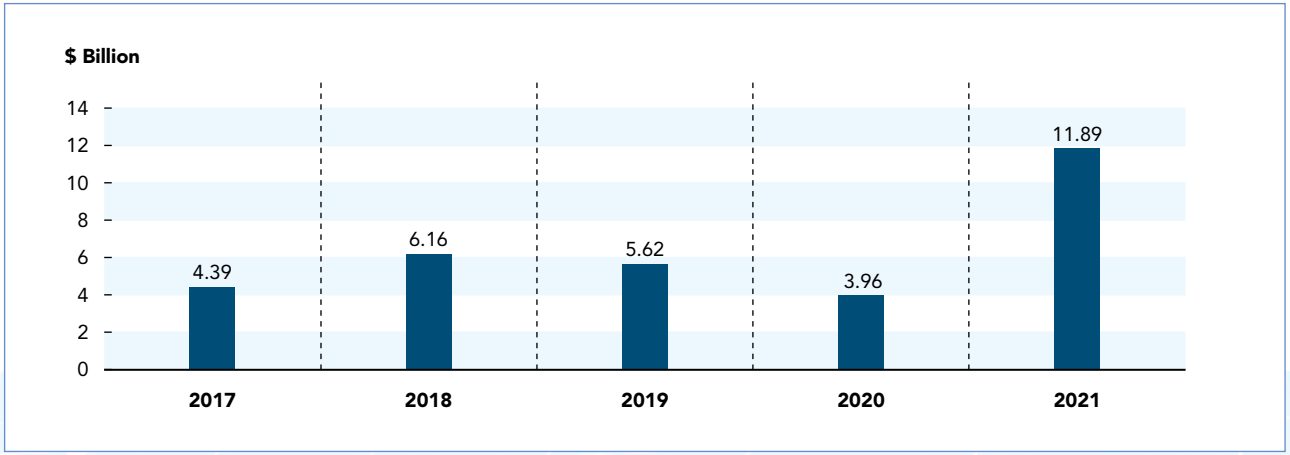
Annual value of products traded rebounds after two consecutive years of decline

The value of products traded shows the transacted value for all products traded in the NEMS: energy, reserves, and regulation. 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.

The annual value of products traded rose threefold year-on-year to a record high of $11.89 billion in 2021. This was only the second time that the annual value of products traded surpassed $10 billion; the first occurrence was in 2012 when it traded at $10.90 billion. With USEP increasing more than two and a half-fold year-on-year and higher electricity consumption, it resulted in an increase in the annual value of products traded.

For 2021, the energy market accounted for 99.1 percent of all products traded, while the reserve and regulation markets accounted for 0.7 percent and 0.2 percent respectively.

Annual Value of Products Traded 2017–2021



MARKET PERFORMANCE:

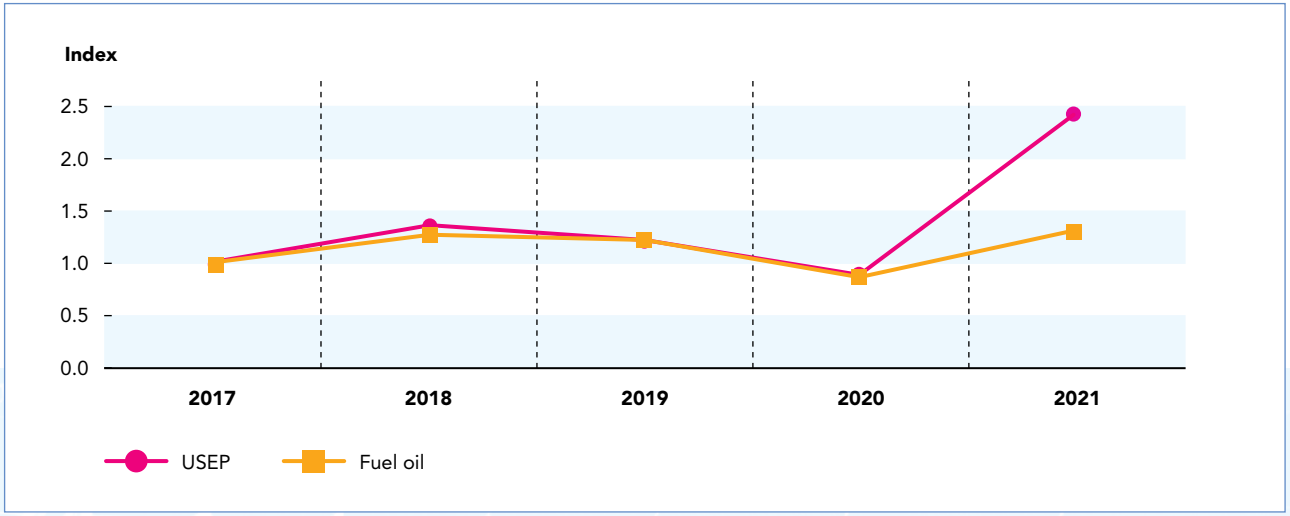
OVERVIEW OF THE YEAR

USEP rebound parallels that of oil prices[7]

The USEP index[8] increased in 2021 to 2.43, while the fuel oil price index increased to 1.32. Both indices moved in tandem with each other, with the USEP index leading the increase.

Both indices rebounded after two consecutive years of decline, in line with the resumption of economic activities and tighter fuel supply. The rise in the USEP index outpaced that of the fuel oil price index in 2021, widening the gap between these two indices.

Annual USEP and Fuel Oil Price Movements 2017–2021

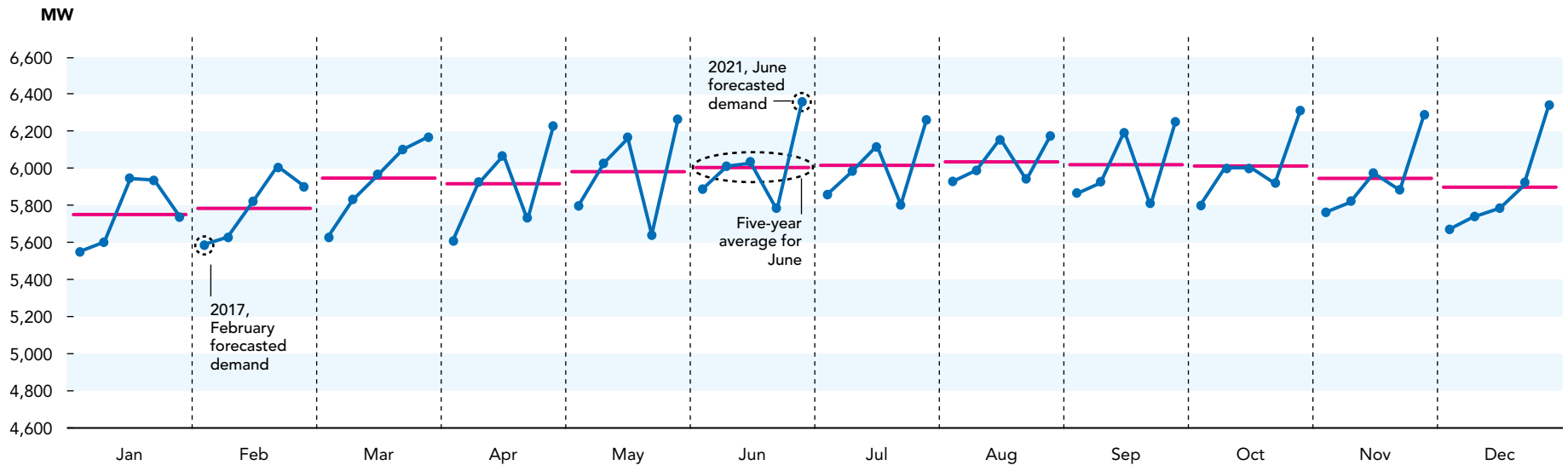


7 *Based on a proxy for fuel oil price.*

8 *The USEP index is computed using 2017 as the index base. Therefore, the USEP index in 2017 is 1, while the USEP index in 2021 is 2.43 (computed using the 2021 USEP of $196.33/MWh divided by the 2017 USEP of $80.90/MWh).*

ENERGY DEMAND

Monthly Forecasted Demand 2017–2021



Forecasted demand increases 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 averaged 6,180MW, an increase of 5.4 percent from 2020. The monthly forecasted demand reached new highs for all months in 2021 apart from January and February.

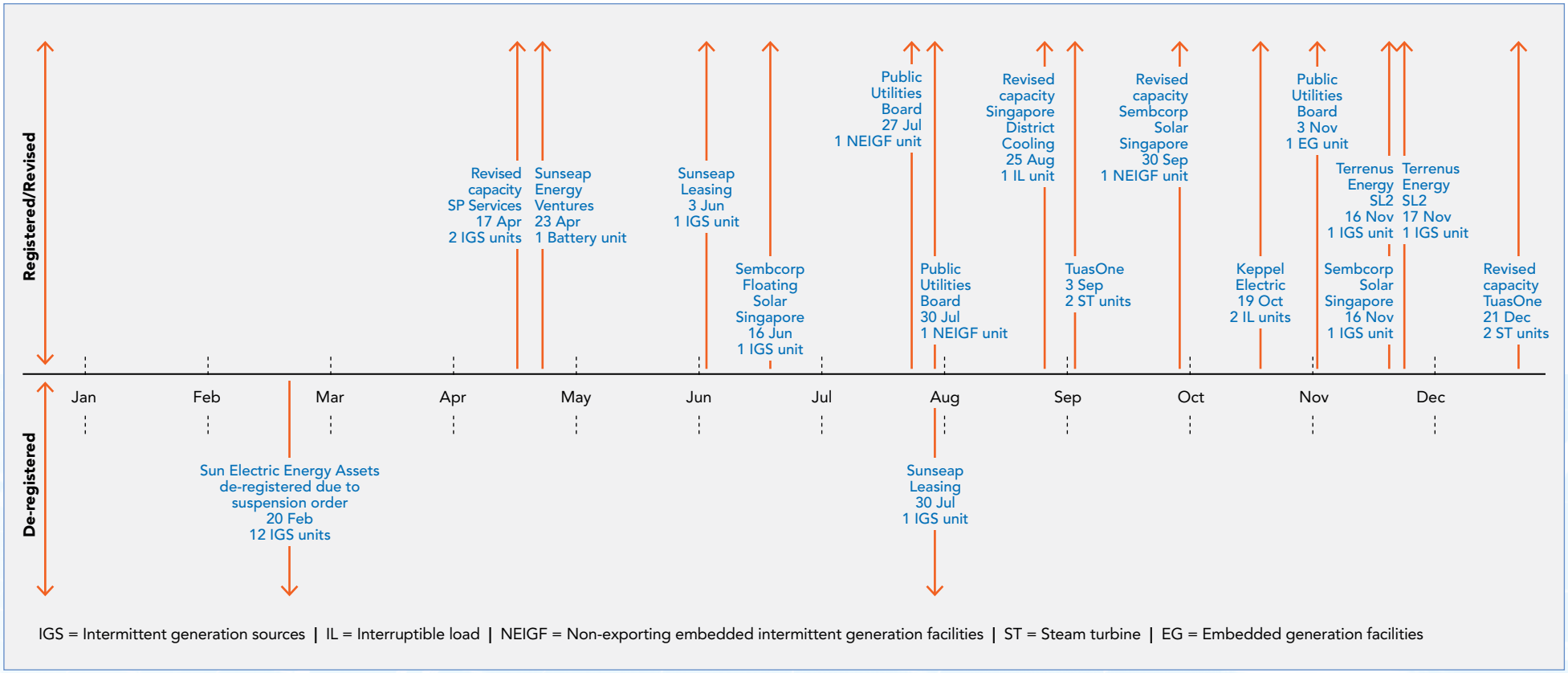
Compared to 2020, demand was higher in all months except January and February. In 2021, monthly average demand was highest in June, which registered the second largest YOY jump of 9.6 percent to 6,333MW. May's average demand of 6,255MW marked the largest YOY jump of 10.7 percent. Monthly average demand was lowest in January, which registered the sharpest YOY decline of 3.0 percent to 5,751MW. January's YOY decline was in line with cooler weather where monthly temperature was the lowest in the past five years.

The peak half-hourly demand of 7,315MW was recorded in Period 33 on 12 Oct 2021. This was also the highest half-hourly demand recorded since the market started. The peak half-hourly demand in 2021 was 4.0 percent higher than 2020's peak of 7,034MW recorded in Period 22 on 11 Aug 2020.

MARKET PERFORMANCE:

ENERGY SUPPLY

Generation and Load Facilities Registered, De-registered and Revised in 2021



IGS = Intermittent generation sources | IL = Interruptible load | NEIGF = Non-exporting embedded intermittent generation facilities | ST = Steam turbine | EG = Embedded generation facilities

11 new generation facilities and two new load facilities registered in 2021

At the end of 2021, the total registered capacity of generation facilities in the NEMS stood at 12,165MW[9]. Out of this, 86.4 percent or 10,516MW belonged to the CCGT/cogen/trigen category. As at 31 December 2021, there were 118 generation facilities and five load facilities registered in the NEMS.

During the year, 13 new facilities were added from eight MPs which collectively contributed seven intermittent generation source (IGS)[10] facilities, two ST facilities, one embedded generation facility, one battery facility and two load facilities to the market. A breakdown of the new facilities registered can be seen from the table below. In addition, three IGS facilities, two ST facilities and one load facility recorded capacity revisions. A breakdown of the capacity revisions can be found in the table below.

With regard to de-registrations, 13 IGS facilities were de-registered in 2021 – 12 IGS units from Sun Electric Energy Assets at 2.17MW, and one IGS unit from Sunseap Leasing at 0.43MW. Sun Electric Energy Assets was suspended from the market, resulting in the de-registration of its 12 IGS units.

New facilities registered

Market Participant	Generation Type	Registered Capacity
Keppel Electric	2 IL units	1.000MW each
Public Utilities Board	2 NEIGF units	1.470MW, 1.900MW
Public Utilities Board	1 EG unit	3.904MW
Sembcorp Floating Solar Singapore	1 IGS unit	40.000MW
Sembcorp Solar Singapore	1 IGS unit	13.320MW
Sunseap Energy Ventures	1 Battery unit	4.900MW*
Sunseap Leasing	1 IGS unit	3.600MW
Terrenus Energy SL2	2 IGS units	8.460MW, 8.200MW
TuasOne	2 ST units	66.700MW each

* *The actual generation capacity is 2.400MW, with a modelled capacity of 4.900MW.*

Capacity Revisions

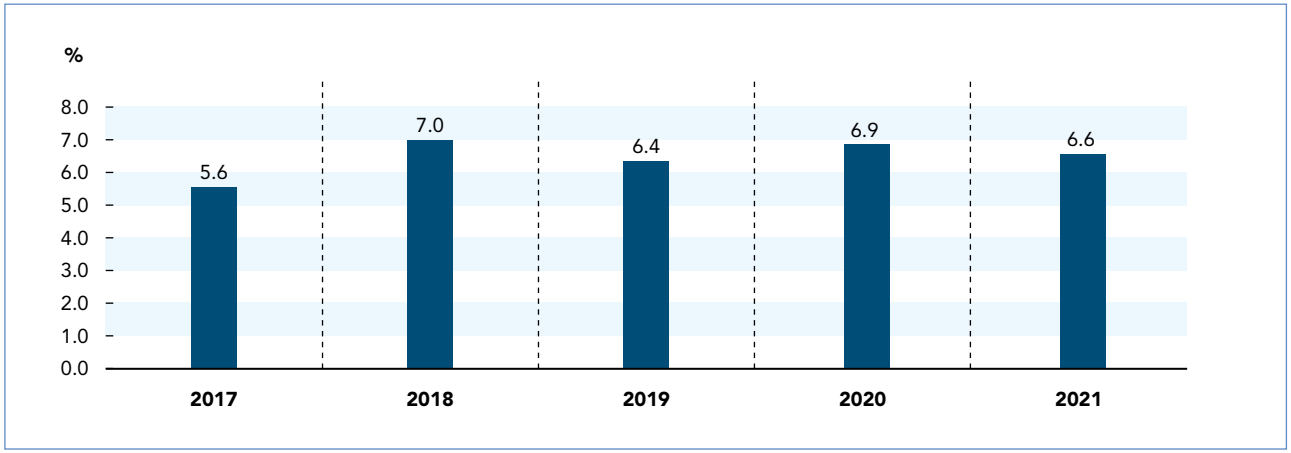
Market Participant	Generation Type	Registered Capacity
Sembcorp Solar Singapore	1 NEIGF unit	6.520MW
Singapore District Cooling	1 IL unit	5.000MW
SP Services	2 IGS units	145.306MW, 3.429MW
TuasOne	2 ST units	68.100MW each

9 Excludes battery facility.
10 Includes NEIGFs registered in 2021.

MARKET PERFORMANCE:

ENERGY SUPPLY

Embedded Generator Generation Market Share 2017–2021

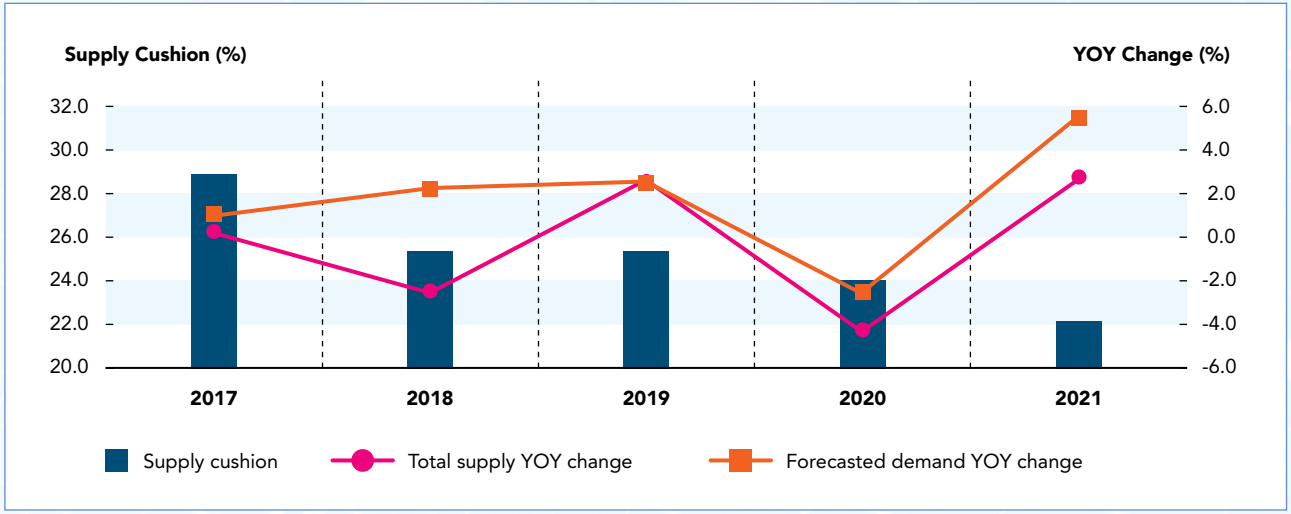


Embedded generator generation market share declines in 2021

The market share of embedded generators (EGs) in the NEMS reversed its increase in 2020, shrinking from 6.9 percent in 2020 to 6.6 percent in 2021. This was due to higher maintenance of EG facilities.

The highest monthly EG generation market share was registered in March at 7.5 percent, while the lowest was in August at 5.2 percent. The standard deviation was 0.66 percent, down from 2020's standard deviation of 0.69 percent.

Annual Supply Cushion 2017–2021



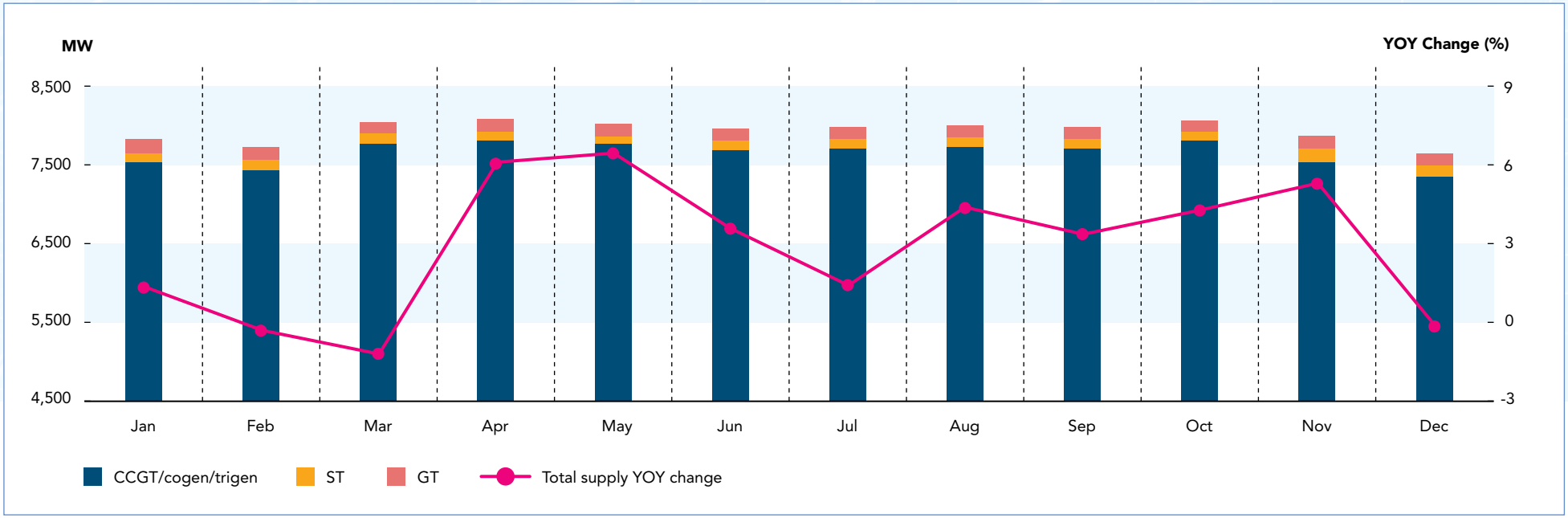
Supply cushion shrinks in 2021

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 2021, the total supply increased at a slower rate than the forecasted demand. This resulted in a 1.9 percentage points contraction in the supply cushion to 22.2 percent, which was the lowest annual supply cushion level since the market started.

ENERGY SUPPLY

Monthly Supply by Plant Type 2021



Total supply increases with most months registering YOY growth

In 2021, total supply registered YOY growth of between 1.3 percent and 6.6 percent for nine out of 12 months. This outweighed the YOY declines in total supply for February, March and December, and resulted in higher total supply overall for the year compared to 2020.

The total supply in April and May in 2021 was significantly higher than that for the same months in 2020, a reflection of the impact of CB restrictions on total supply in April and May 2020.

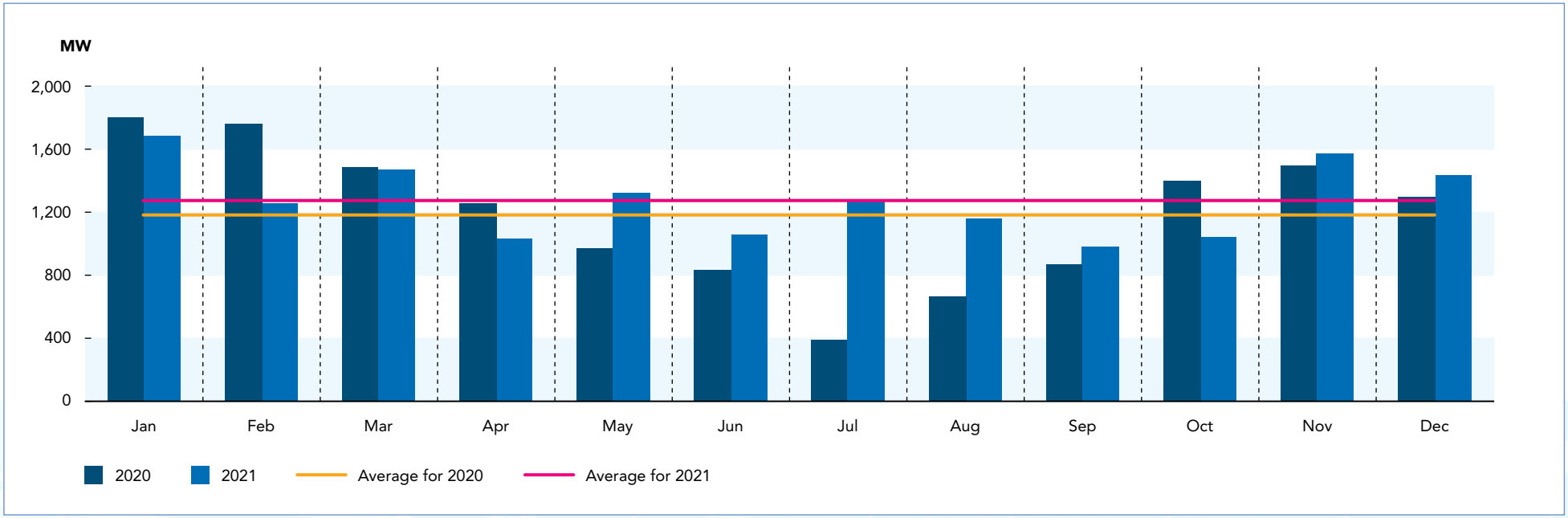
The most efficient generation type – CCGT/cogen/trigen – continued to lead in market share, making up 96.4 percent of the total supply. This was a 0.4 percentage point decrease from their market share in 2020. The market shares of ST and GT increased by 0.1 and 0.3 percentage point, to 1.6 percent and 2.0 percent respectively.

In 2021, the monthly supply exceeded the 8,000MW level for five months, compared to a month in 2020. The lowest monthly supply of 7,650MW was recorded in December.

MARKET PERFORMANCE:

ENERGY SUPPLY

Monthly Generation Maintenance 2020 Versus 2021



Generation maintenance increases

The annual average generation maintenance level[11] increased 7.4 percent in 2021 to 1,269MW. The monthly generation maintenance levels were higher YOY between May and September, and in November and December. The highest monthly average generation maintenance level of 1,690MW was in January, while the lowest level of 979MW was in September.

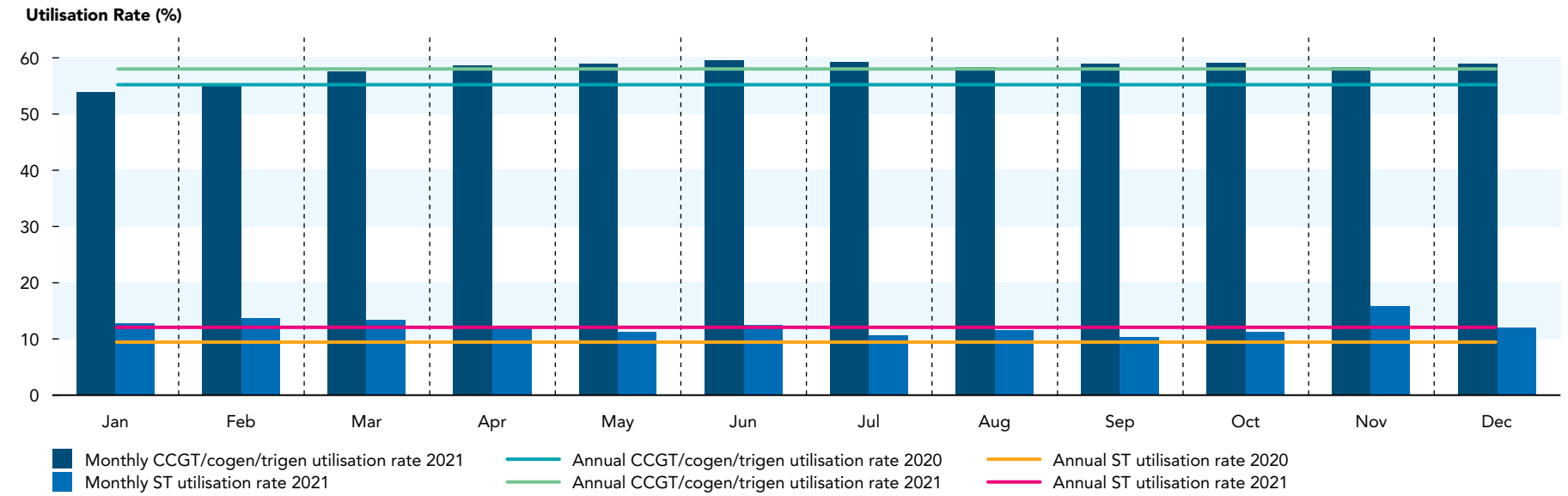
The standard deviation of monthly generation maintenance decreased from 440MW in 2020 to 230MW in 2021, as the monthly generation maintenance range narrowed to between 979MW and 1,690MW.

The ratio of generation maintenance to registered capacity increased from 10.0 percent in 2020 to 10.4 percent in 2021.

11 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.

ENERGY SUPPLY

Monthly Utilisation Rate by Plant Type 2021



Utilisation rate for all plant types improve

In 2021, the monthly CCGT/cogen/trigen utilisation rate ranged between 53.8 percent in January and 59.4 percent in June. Apart from January and February, the utilisation rate was higher in all months compared to 2020, with the largest increase of 5.6 percentage points seen in May.

Overall, the CCGT/cogen/trigen utilisation rate in 2021 rose 2.8 percentage points to 57.8 percent. The higher utilisation rate reflects stronger demand in 2021.

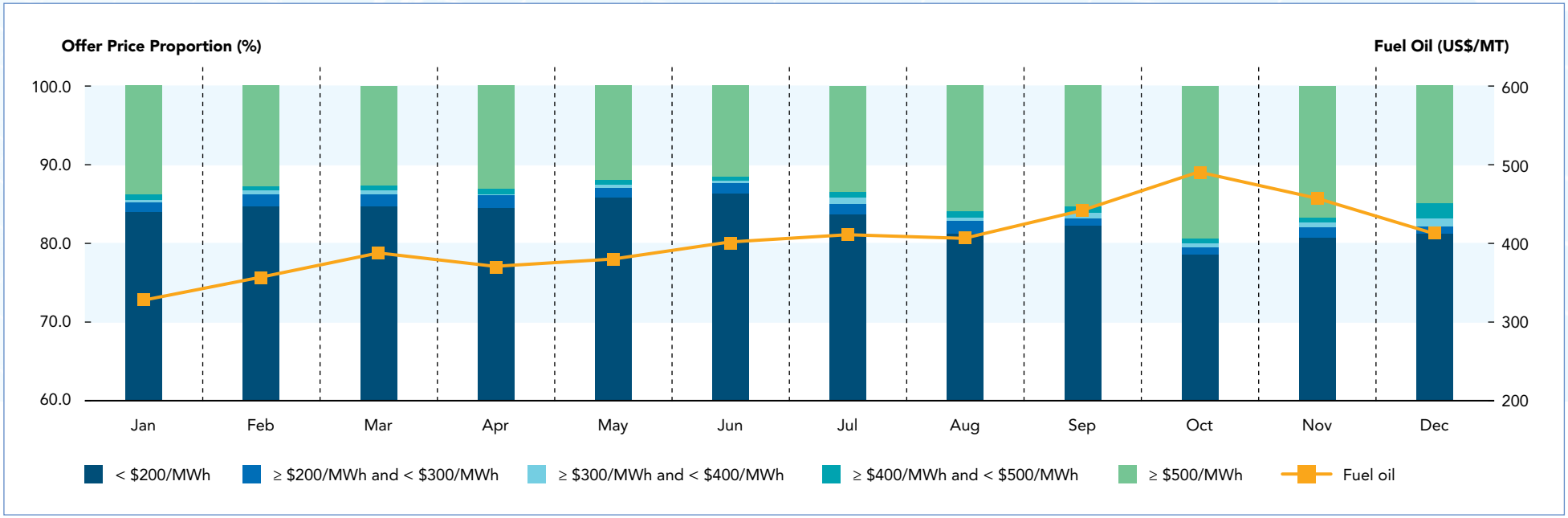
The monthly ST utilisation rate in 2021 ranged between 10.0 percent in September and 15.7 percent in November. It was higher in ten out of 12 months compared to 2020 – with the largest increase of 5.5 percentage points seen in the months of March, April and May. The annual ST utilisation rate improved 2.7 percentage points to 12.1 percent in 2021, the highest level recorded since 2012.

The annual GT utilisation rate in 2020 was low as compared to the annual GT utilisation rate of 2.6 percent in 2021.

MARKET PERFORMANCE:

ENERGY SUPPLY

Monthly Energy Offer Price Proportion and Fuel Oil Price 2021



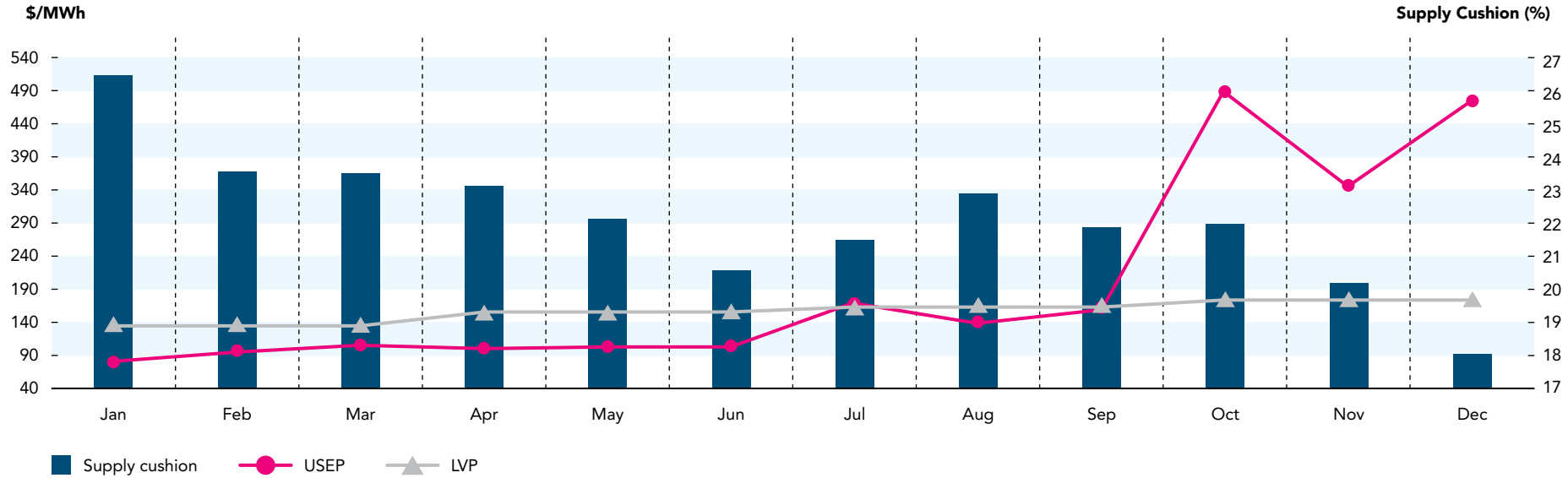
Energy offer prices shift in tandem with increasing fuel oil prices

In 2021, the daily fuel oil price ranged between US$323.92 per metric tonne (MT) and US$492.98/MT. The highest monthly level was registered in October, while the lowest monthly level was recorded in January.

Fuel oil prices climbed steadily from US$323.92/MT in January to US$492.98/MT in October and stayed above US$400.00/MT for the remaining months. The increase in fuel prices reflected the recovery of global demand and economic activity as Covid-19 restrictions eased.

Throughout 2021, the proportion of energy offers moved largely in tandem with fuel oil prices. In particular, in the first half of 2021 the proportion of energy offers above $500.00/MWh averaged at 12.7 percent and this increased to 16.0 percent in the second half of 2021 as the fuel oil price crosses US$400.00/MT. The proportion of energy offers below $200.00/MWh averaged above 80.0 percent for all months except October. That month, the proportion of energy offers in this price band fell to its lowest – 78.5 percent – coinciding with the highest monthly fuel oil price for the year.

Monthly USEP, LVP and Supply Cushion 2021



USEP stays below LVP benchmark for most months

In 2021, the USEP registered below the LNG Vesting Price (LVP) for eight months. The spread between the monthly minimum USEP of $77.81/MWh and the monthly maximum USEP of $491.24/MWh was more than 9 times larger compared to 2020, at $413.43/MWh.

In 2021, the annual average LVP was $43.24/MWh or 22.0 percent lower than the annual average USEP. The trend between the annual average LVP and annual average USEP was a reversal from 2020 as 2020's annual average LVP was higher than the annual average USEP by $68.35/MWh. The largest gap between the monthly USEP and the monthly LVP was in October, when the USEP was $320.74/MWh above the LVP. The smallest gap was observed in September when the LVP was $4.34/MWh above the USEP.

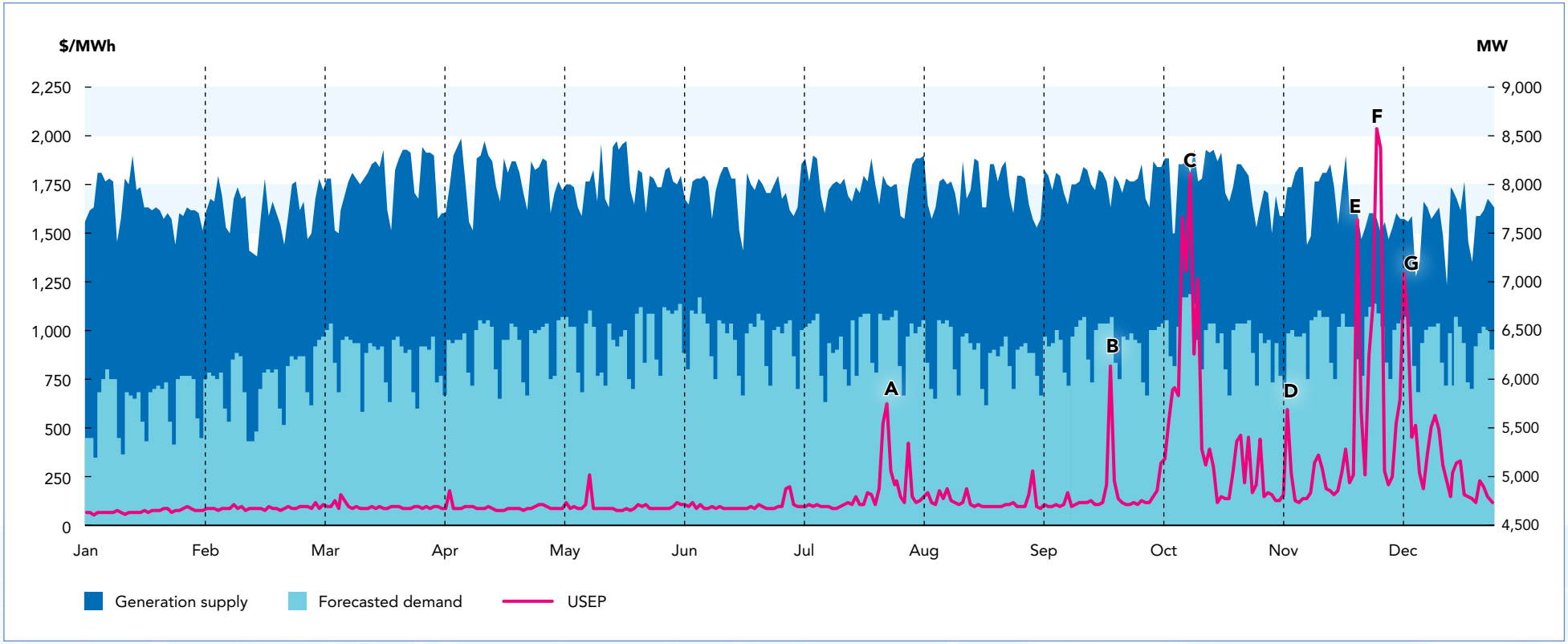
Notably, the surge in USEP against the LVP was most evident in October, November and December. In these months, the spread between the USEP and the LVP was greater than $170.00/MWh. The rise in fuel oil prices coupled with gas curtailment issues led to higher energy offer prices which in turn, resulted in sustained price spikes in these months.

The monthly supply cushion was below 24.0 percent in all months except January. 2021's annual supply cushion of 22.2 percent was 1.9 percentage point lower than 2020's.

MARKET PERFORMANCE:

ENERGY PRICES

Daily USEP, Forecasted Demand and Generation Supply 2021



The key observations on the USEP fluctuations in 2021 are as follows:

Point A: On 27 July (Tuesday), two CCGT units and a EG unit were on planned maintenance, another CCGT unit was on partial planned maintenance, and another EG unit was on unplanned maintenance. The daily average USEP was $640.18/MWh while the peak periodic USEP was $1,514.86/MWh in Period 35. The average demand of 6,453MW was 7.8 percent higher than demand on the preceding Tuesday, which was a public holiday. An upstream gas curtailment between 16.0 and 20.0 percent was observed. The supply cushion was below 20.0 percent from Periods 17 to 43 and the average USEP for these periods was $974.96/MWh.

Point B: On 23 September (Thursday), there was one CCGT unit on planned maintenance, one CCGT unit on partial planned maintenance, and another CCGT unit on unplanned maintenance. In addition, one EG unit and one ST unit experienced forced outages in Periods 26 and 31 respectively. Apart from the units on maintenance, there was an upstream gas curtailment between 6.0 and 10.0 percent. The daily average USEP was $829.55/MWh and the daily average supply cushion of 17.5 percent was the second lowest level in 2021.

The supply cushion stayed below 17.0 percent from Periods 17 to 45 and within these periods, the USEP cleared above $1,100.00/MWh for 22 periods. The USEP peaked at $2,036.02/MWh in Period 45 when the supply cushion was 16.7 percent. Demand response (DR) curtailment was scheduled in Periods 21 to 25, 27, 31 and 34. GT was also scheduled in Periods 21 to 24, 29, 32 to 35 and 38 to 44.

Point C: On 14 October (Thursday), the daily average USEP was $1,821.60/MWh and the daily average supply cushion was 18.0 percent. There was one CCGT unit on planned maintenance and another CCGT unit on partial planned maintenance. An upstream gas curtailment between 1.0 and 5.0 percent was observed as well. The average demand of 6,654MW was 3.4 percent higher than demand on the preceding Thursday and was the highest daily average level since the market started. In addition to the strong demand, one CCGT unit and two EG units experienced forced outages in Periods 19, 34 and 46 respectively. An interruptible load (IL) activation advisory was issued in Period 19 due to the CCGT forced outage; the load restoration advisory was subsequently issued in Period 21.

The USEP averaged above $1,200.00/MWh for a total of 31 periods from Periods 17 to 47. Of these 31 periods, 13 periods registered USEP levels of more than $3,000.00/MWh. The USEP peaked at $3,811.16/MWh in Period 23 when supply cushion was 10.0 percent. Contingency reserve shortfall was also recorded in Periods 21 and 22 and GT was scheduled from Periods 25 to 46. DR curtailment was scheduled in Periods 23 to 30, 32, 34, 35, 38 and 41. The PSO advised that the power system was at a high-risk operating state in Period 21, and in an emergency operating state in Period 22.

Point D: On 8 November (Monday), there was one CCGT unit on planned maintenance, two CCGT units on partial planned maintenance, one CCGT unit on unplanned maintenance, and two other EG units on unplanned maintenance. Separately, one EG unit experienced forced outage in Period 8. The daily average USEP was $604.50/MWh while the peak periodic USEP was $2,509.06/MWh in Period 27. The supply cushion stayed below 16.0 percent from Periods 19 to 35. Amongst these periods, the USEP cleared above $1,000.00/MWh for 11 periods and GT was scheduled for 11 periods as well. DR curtailment was scheduled in Periods 19 to 23, and Periods 26 to 28. An upstream gas curtailment between 1.0 and 5.0 percent was also observed.

Point E: On 26 November (Friday), the daily USEP averaged $1,586.44/MWh with 22 periods registering USEP levels of above $1,200.00/MWh. During these periods of higher USEP levels, the supply cushion averaged 11.1 percent and the peak periodic USEP was $3,921.79/MWh in Period 31 when supply cushion was 9.0 percent. There were three CCGT units on planned maintenance, one CCGT unit on partial planned maintenance, and two EG units on unplanned maintenance. In addition, one other CCGT unit tripped in Period 28. An upstream gas curtailment between 1.0 and 5.0 percent was also observed.

Contingency reserve shortfall was recorded for a total of six periods (Periods 29, 30, 33, 34, 35 and 43) and DR curtailment was scheduled for a total of 13 periods (Periods 21 to 24, Periods 27 to 32, Periods 35, 37 and 39). The PSO advised that the power system was at a high-risk operating state in Periods 29, 33 and 43, and in an emergency operating state in Periods 30, 34, 35 and 44.

Point F: On 1 December (Wednesday), the daily average USEP was $2,058.85/MWh. This was the highest daily average USEP since the market started. There were two CCGT units on planned maintenance, one CCGT unit on partial planned maintenance, one CCGT unit on unplanned maintenance, and one other EG unit on unplanned maintenance. Separately, there was an upstream gas curtailment between 1.0 and 5.0 percent on this day. The average demand was 6,585MW, 3.1 percent higher than the demand on the preceding Wednesday. The supply cushion stayed below 12.0 percent from Periods 17 to 34 and averaged 10.7 percent for these periods. The peak periodic USEP for the day observed in Period 20 at $3,640.33/MWh saw the lowest supply cushion of the day at 8.7 percent. DR curtailment was scheduled from Periods 17 to 30 and from Periods 32 to 38.

On 2 December (Thursday), the daily average USEP was $1,960.36/MWh. This was the second highest daily average USEP since the market started, after 1 Dec 2021. Notably, there were 31 periods registering USEP levels above $1,100.00/MWh. Out of these 31 periods, there were two periods of USEP at $4,499.09/MWh. This was the peak periodic USEP for 2021. There were two CCGT units on planned maintenance, one CCGT unit on partial planned maintenance, two CCGT units on unplanned maintenance, and one other EG unit on unplanned maintenance. Separately, there was an upstream gas curtailment between 1.0 and 5.0 percent on this day. The high maintenance levels and gas curtailment resulted in a 3.2 percent decrease in total supply as compared to the preceding Thursday. Concurrently, the average daily demand of 6,509MW was 1.9 percent higher than the demand on the preceding Thursday. The confluence of weaker supply and stronger demand factors led to a 4.3 percentage points contraction in the supply cushion to 13.7 percent. On a periodic level, the supply cushion stayed below 10.0 percent between Periods 18 and 34.

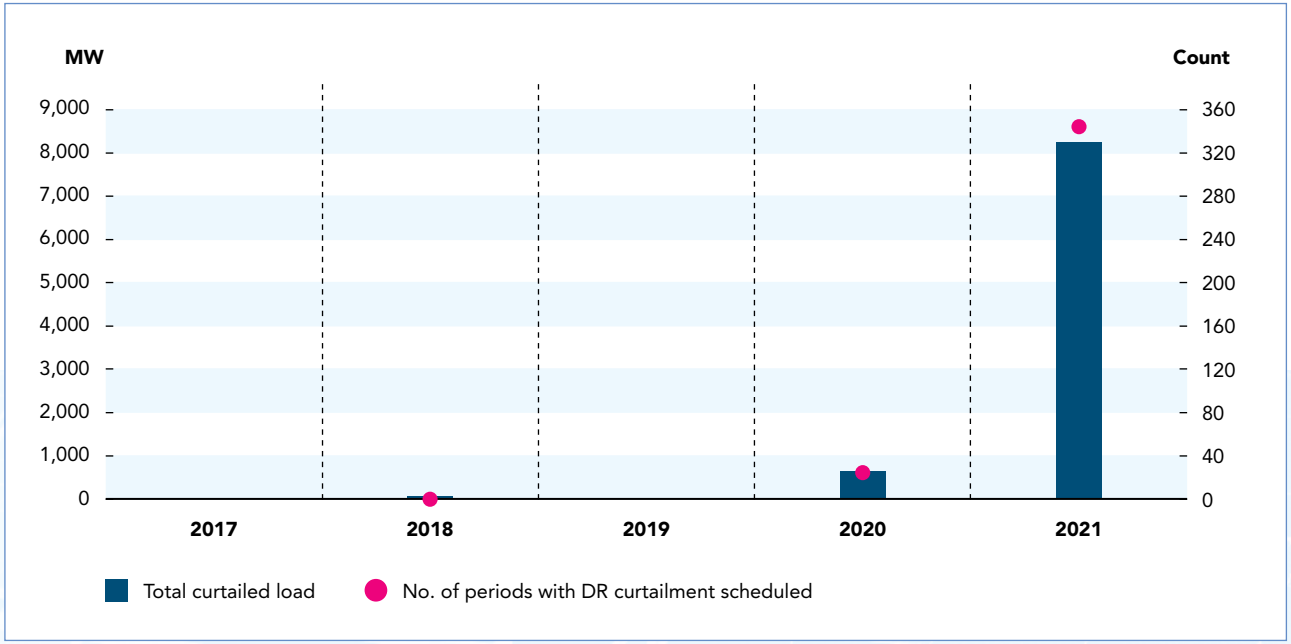
Contingency reserve shortfall was recorded for a total of 11 periods (Periods 20 to 23, Periods 25 and 31) and regulation shortfall was recorded for a total of three periods (Periods 20 to 22). Separately, DR curtailment was scheduled for a total of 30 periods (Periods 14 to 35, Periods 38 to 45). The PSO advised that the power system was at a high-risk operating state in Periods 20 and 25, and in an emergency operating state in Periods 21, 23 and 26.

Point G: On 8 December (Wednesday), there was one CCGT unit on planned maintenance and one CCGT unit on partial planned maintenance. In addition, one CCGT unit and one EG unit were on unplanned maintenance. An upstream gas curtailment between 1.0 and 5.0 percent was also observed. The daily average USEP was $1,314.10/MWh while the peak periodic USEP was $3,998.71/MWh in Period 43 when supply cushion was at a low of 10.4 percent. The overall supply cushion was lower from Periods 20 to 45, compared to the preceding Wednesday. Notably, the USEP was above $1,000.00/MWh for a total of 19 periods. DR curtailment was scheduled in Period 23 and from Periods 28 to 34.

MARKET PERFORMANCE:

DEMAND RESPONSE

Annual Demand Response Curtailment Scheduled 2017–2021



Number of periods with Demand Response curtailment scheduled peaks in 2021

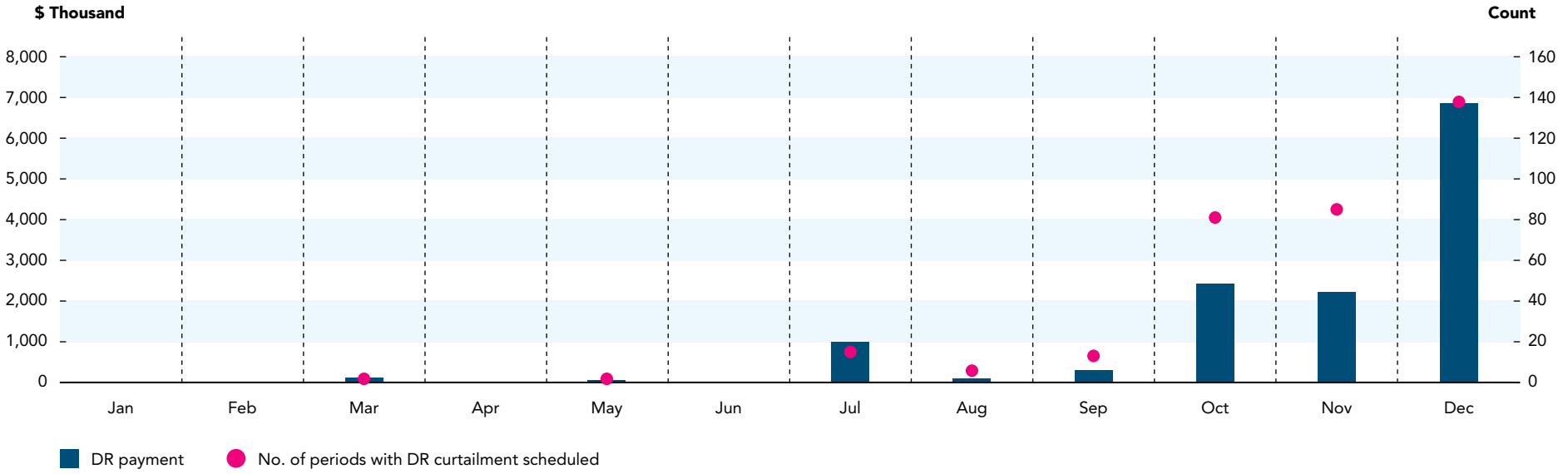
The Demand Response (DR) programme was introduced in 2016 to enable contestable consumers to participate directly in the wholesale market by reducing their electricity demand voluntarily in response to market conditions. This is particularly during periods of high wholesale market prices or when system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

A total of 343 periods of DR curtailment were scheduled in 2021, up from 23 in 2020. This was the highest number of periods with DR curtailment scheduled since DR was implemented in 2016. The increase in the number of periods with DR curtailment scheduled was attributed to greater occurrences of higher USEP. The total curtailed load in 2021 was at 8,245MW.

As at 31 Dec 2021, there were two DR providers in the market.

DEMAND RESPONSE

Monthly Demand Response Payment 2021



DR payment amount increases with more DR activation

In 2021, the spread between the Counterfactual Uniform Singapore Energy Price (CUSEP) and USEP ranged between -$1,232.21/MWh and $2,495.46/MWh, and averaged at $174.30/MWh. This indicates that with each MW, consumers benefitted from estimated average cost savings of $174.30/MWh. This was higher than the estimated average cost saving of $100.37/MWh for each MW in 2020.

The annual DR payment totalled $13.3 million in 2021, up from $0.9 million in 2020. The higher annual payment was in line with the higher frequency of DR curtailment scheduled. There were eight months with DR payments as compared to five months in 2020. DR curtailment occurred most frequently in December, which had 138 periods of DR curtailment scheduled.

For 2021, a total of $115,884.12 in DR penalties were incurred due to deviation from the dispatch schedule. The DR penalty amount was the highest in October at $36,779.59 and lowest in May and August at $5,000.00 each. The DR penalty accounted for 0.9 percent of the total DR amount transacted.

MARKET PERFORMANCE:

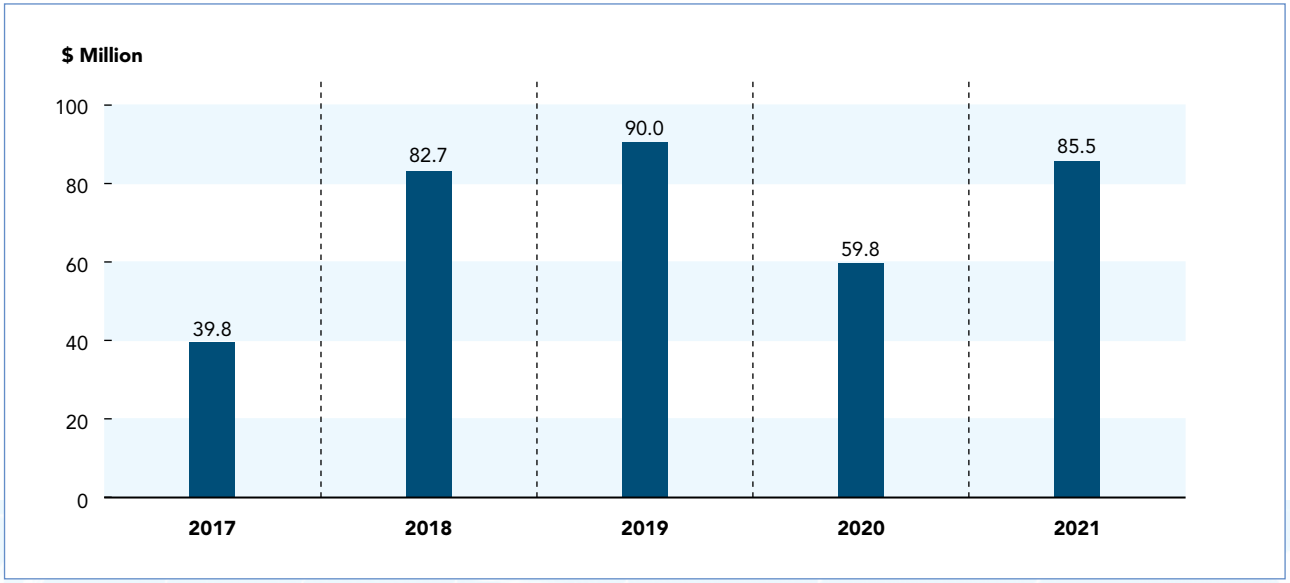
ANCILLARY MARKETS

Reserve payment increases in 2021

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 former being nine seconds for primary reserve and ten minutes for contingency reserve. The generators bear the cost of procuring the reserves.

Compared to 2020, reserve costs increased 43.0 percent to $85.5 million. This was primarily driven by an increase in contingency reserve prices and the higher contingency reserve requirement. The contingency reserve price rose $4.52/MWh to $14.43/MWh. The contingency reserve requirement increased from 596MW to 605MW.

Annual Reserve Payment 2017–2021



Reserve provider group effectiveness in Groups A and B continues to improve

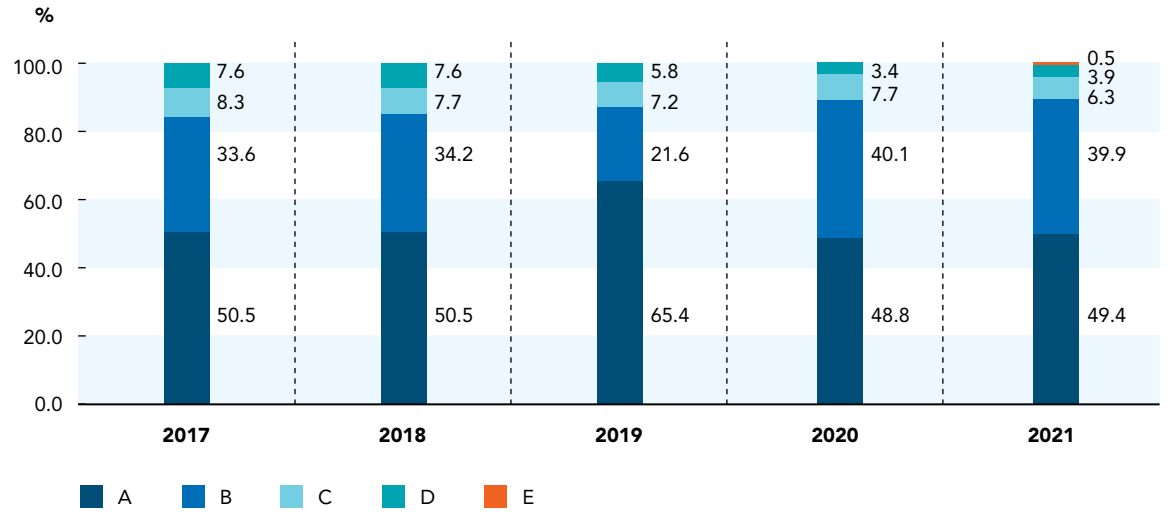
Reserve providers in the NEMS are classified into five groups, with Group A reflecting reserve providers with the highest level of responsiveness and Group E reflecting those with the lowest level of responsiveness. A higher level of responsiveness attracts a higher proportion of reserve price.

In 2021, some of the reserve providers in Groups B and C moved into Groups A, D and E. The percentage of reserve providers in Group A increased 0.6 percentage point while that for both Groups D and E increased 0.5 percentage point each. In contrast, the percentage of reserve providers in Groups B and C decreased 0.2 percentage point and 1.4 percentage points respectively.

Overall, the reserve provider group effectiveness improved slightly in 2021. A larger 89.3 percent of reserve providers fell into the more responsive Groups A and B, while the proportion of reserve providers in the less responsive Groups C and D shrank to 10.2 percent. There was one reserve provider in Group E in 2021 and the previous instance when a reserve provider was in this category was in 2014.

All contingency reserve providers were classified in Group A.

Reserve Provider Group Effectiveness for Primary Reserve Class (Aggregate) 2017–2021

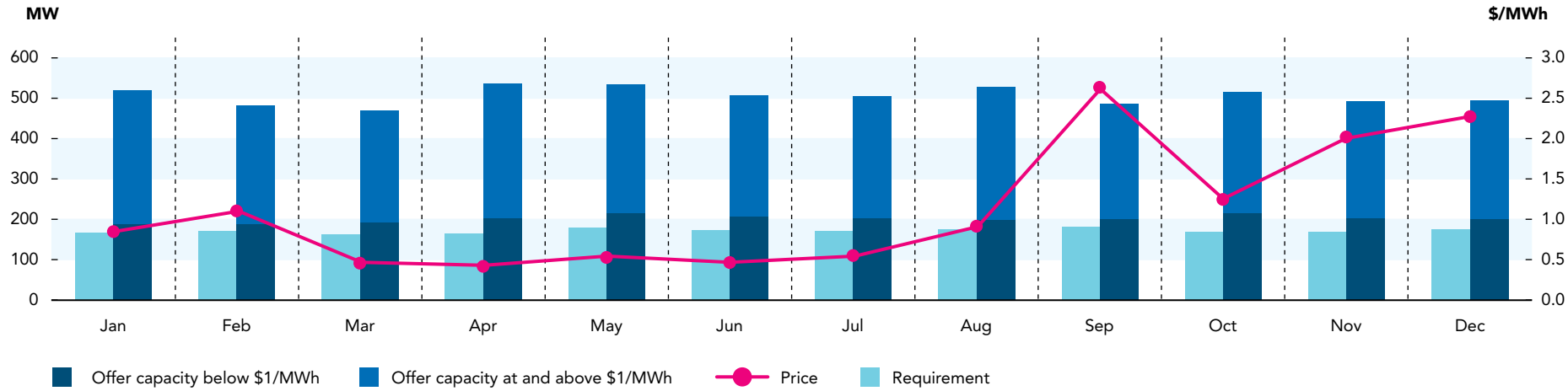


Statistics exclude IL providers.

MARKET PERFORMANCE:

ANCILLARY MARKETS

Monthly Primary Reserve Price, Requirement and Supply 2021



More stable primary reserve prices with no RAF adjustments, shortfalls and intertie disconnections

The annual average primary reserve price rose marginally from $1.08/MWh in 2020 to $1.13/MWh in 2021. The highest monthly primary reserve price was $2.68/MWh in September, followed by $2.33/MWh in December. The lowest monthly average of $0.42/MWh was observed in April.

The annual average primary reserve requirement fell 10.4 percent to 173MW in 2021. The annual primary reserve offers rose 0.4 percent higher to 511MW.

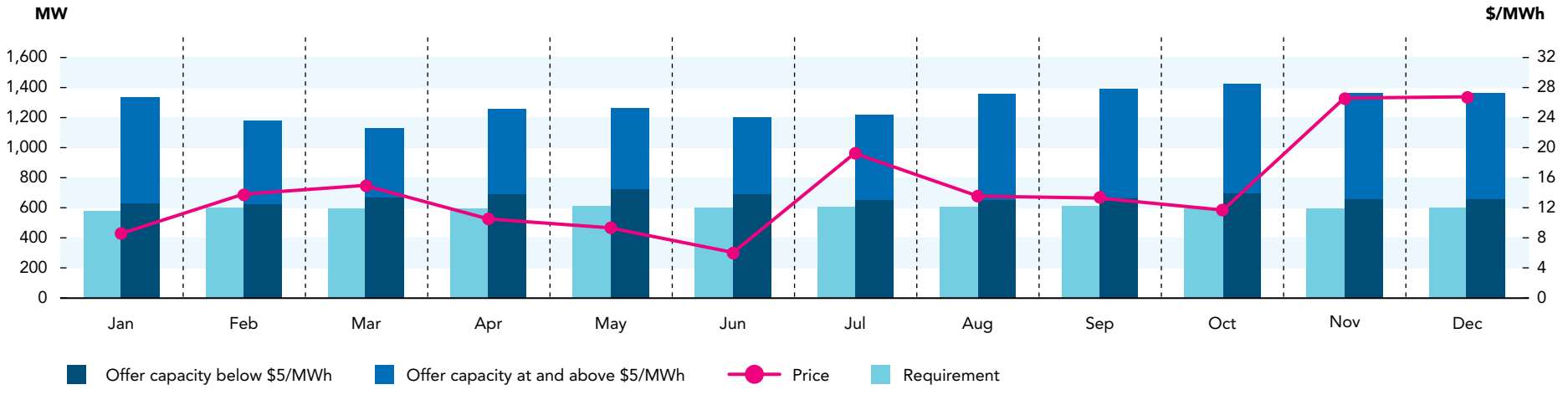
On a monthly basis, the primary reserve requirement ranged between 164MW and 183MW in 2021, with the lowest level seen in March, and the highest in September. The monthly primary reserve offers averaged above 500MW for the months of January, April to August, and October. The monthly primary reserve offers were lowest in March at 474MW and highest in April at 541MW. The proportion of primary reserve offers below $1.00/MWh ranged between 36.1 percent and 41.5 percent in 2021.

Compared to 2020, there were no periods with intertie disconnections and primary reserve shortfalls in 2021.

There were no changes to the RAF in 2021. It was set at 1.0 for primary reserve.

ANCILLARY MARKETS

Monthly Contingency Reserve Price, Requirement and Supply 2021



Contingency reserve price increases on higher requirement and fewer cheaper offers

The annual average contingency reserve price rose 45.6 percent to $14.43/MWh in 2021. The highest monthly contingency reserve price of $26.85/MWh was observed in December while the lowest monthly contingency reserve price of $6.09/MWh was registered in June.

The annual average contingency reserve requirement rose 1.5 percent to 605MW in 2021. The annual average contingency reserve offers increased 5.8 percent to 1,293MW in 2021. The proportion of contingency reserve offers below $5.00/MWh was 51.5 percent, lower than the 57.5 percent in 2020.

At the monthly level, the contingency reserve requirement stood above 600MW for all months except January. The lowest monthly contingency reserve requirement of 583MW was observed in January, while the highest monthly contingency reserve requirement of 615MW was seen in May. The monthly contingency reserve offers were highest in October at 1,426MW and lowest in March at 1,134MW. The proportion of contingency reserve offers below $5.00/MWh was below 50.0 percent in all months except from February to July.

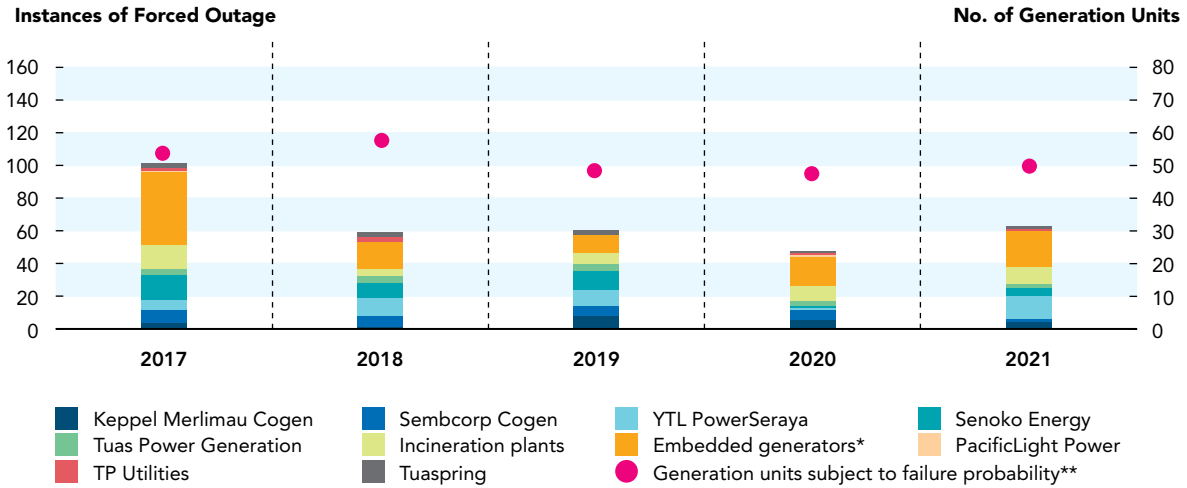
December recorded the most periods with contingency reserve shortfall. December accounted for 19 out of 63 periods with contingency reserve shortfall in 2021, driving the monthly average price to a high of $26.85/MWh.

The RAF for contingency reserve was unchanged at 1.5 in 2021.

MARKET PERFORMANCE:

ANCILLARY MARKETS

Annual Forced Outages by Generation Companies 2017–2021



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.

** Generation units subject to failure probabilty exclude battery.

Total number of forced outages increases

There was a total of 63 forced outages in 2021, a 28.6 percent increase from 2020.

With the exception of three generation companies and embedded generators, all other generation companies experienced the same number or fewer forced outages.

The number of generation units subject to failure probability increased with the commissioning of two new generation facilities in 2021.

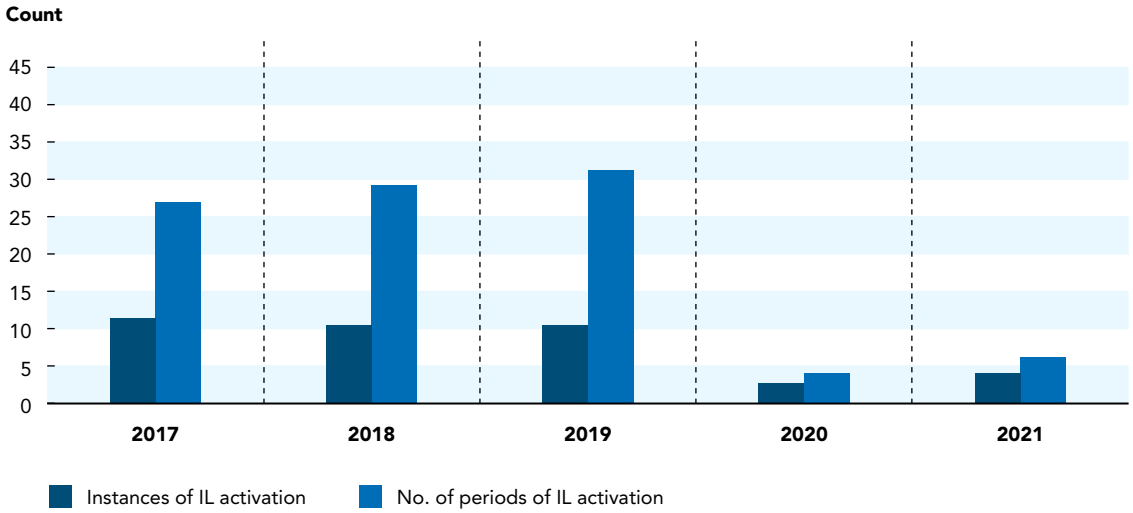
Instances of IL activation increase marginally

As at 31 December 2021, there was no registered capacity for IL for primary reserve. For contingency reserve, the total IL registered capacity increased from 7.9MW to 9.9MW.

In 2021, the number of IL activations for contingency reserve increased from three to four, and the total number of periods when IL was activated for contingency reserve increased from four to six.

The longest continuous stretches of IL activation lasted two periods each, on 14 October and 7 November. There was also one period each of IL activation on 29 June and 22 September.

Annual Interruptible Load (IL) Activations for Contingency Reserve Market 2017–2021

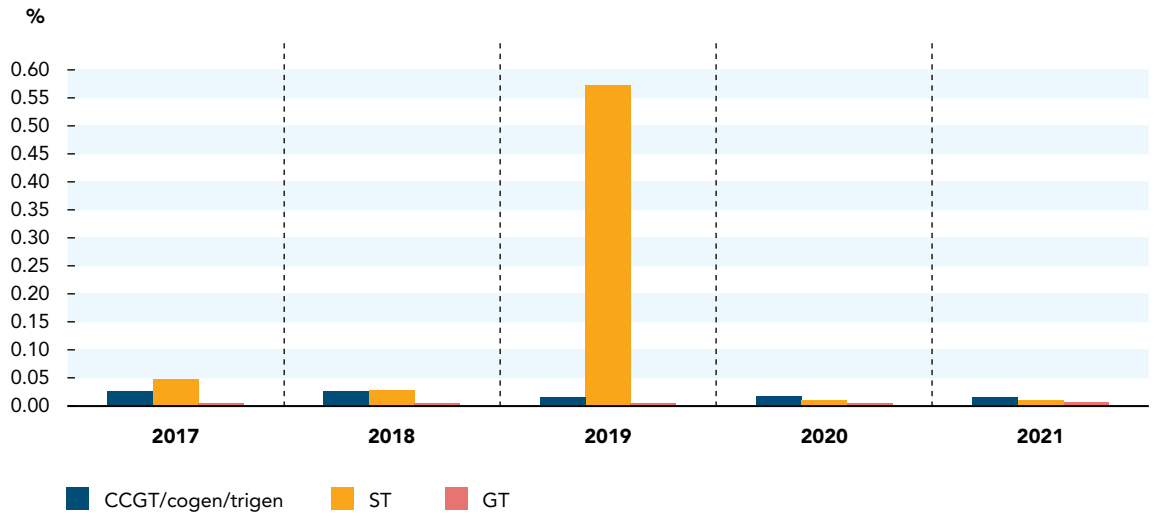


Note: The number of periods of IL activation for 2020 has been revised based on current calculation methodology.

MARKET PERFORMANCE:

ANCILLARY MARKETS

Average Failure Probability by Year 2017–2021



Generation units subject to failure probability exclude battery.

Mixed outcomes in reliability of generation facilities

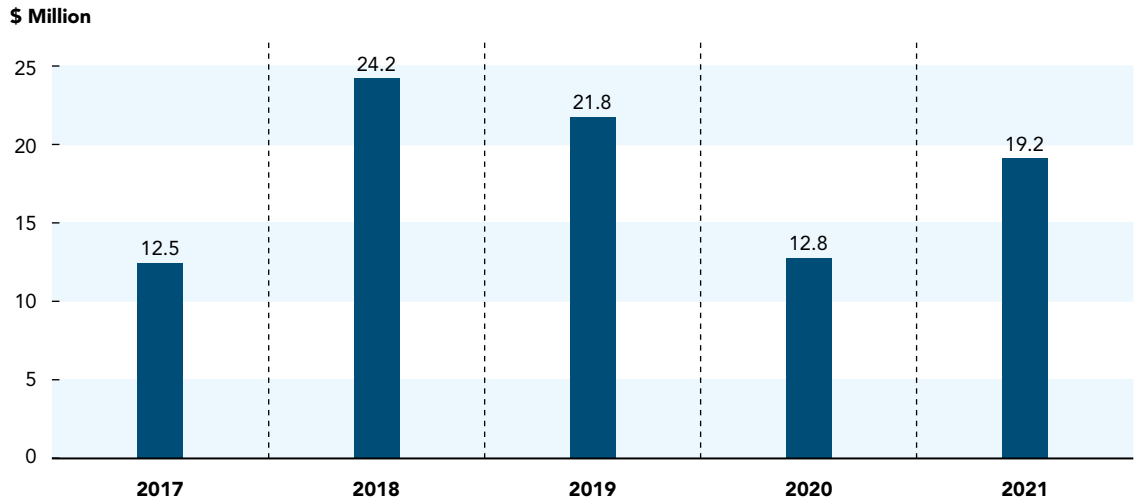
The average failure probability for a Generation Registered Facility (GRF) is the probability that after being dispatched by the PSO for a settlement interval, the GRF will cease operating, disconnect from the transmission system, or both, during that settlement interval, even if no other GRF fails. 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.

In 2021, the average failure probabilities of CCGT/cogen/trigen, ST, and GT facilities were 0.008 percent, 0.006 percent, and 0.001 percent respectively. Compared to 2020, the failure probability of CCGT/cogen/trigen facilities declined while that of ST facilities rose. Despite an increase in the occurrences of forced outages, the failure probability of CCGT/cogen/trigen facilities improved, as CCGT/cogen/trigen was scheduled in a higher number of periods. The increase in the failure probability of ST facilities was attributed to higher occurrences of forced outages by ST facilities. The failure probability of GT facilities remained the same.

ANCILLARY MARKETS

Annual Regulation Payment 2017–2021



Regulation payment increases

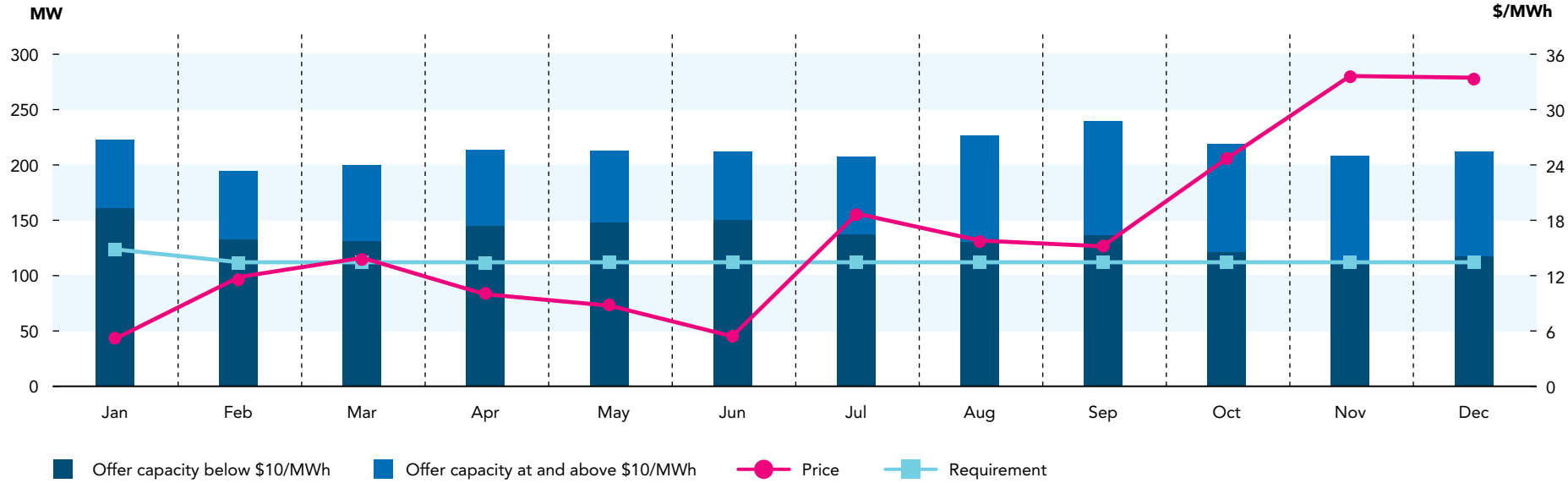
Regulation payment rose 50.0 percent to $19.2 million in 2021. This was in line with a 61.0 percent increase in regulation price to $16.45/MWh.

Compared to 2020, the regulation payment was higher for seven months in the year, with the YOY increase ranging between $0.2 million and $2.2 million. The first half of 2021 contributed to 27.9 percent of the total regulation payment, while the second half of 2021 accounted for the remaining 72.1 percent. Notably, October, November and December recorded regulation payment greater than $2.0 million. The largest YOY increase was in December which registered the highest monthly regulation payment of $3.3 million. The lowest monthly regulation payment was $0.5 million in June.

MARKET PERFORMANCE:

ANCILLARY MARKETS

Monthly Regulation Price, Requirement and Supply 2021



Regulation prices experience greater volatility

In 2021, the annual average regulation price rose 61.0 percent to $16.45/MWh despite a downward revision of the regulation requirement from 123MW to 114MW as of 1 February 2021.

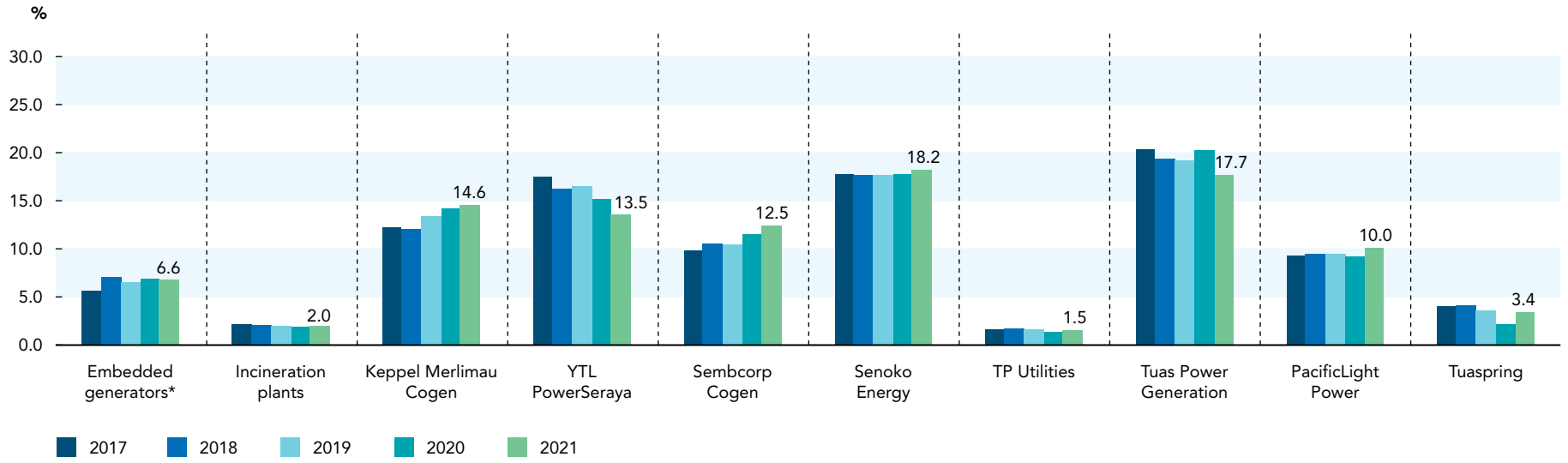
Regulation prices were more volatile in 2021. In 2020, the lowest monthly regulation price was $3.01/MWh in July while the highest was $16.62/MWh in September – a spread of $13.61/MWh. In 2021, this spread widened to $28.41/MWh. The lowest monthly regulation price was $5.19/MWh in January, while the highest was November's $33.60/MWh. The standard deviation increased from $4.77/MWh in 2020 to $9.70/MWh in 2021.

Compared to 2020, the monthly regulation offers were lower YOY for seven months in the year. In addition, the proportion of regulation offers below $10.00/MWh was lower YOY for all months except January, February and May. For the months of October, November and December, the YOY decrease in proportion of regulation offers below $10.00/MWh was greater than 11.0 percent.

There were seven periods of regulation shortfall in 2021, up from four periods in 2020. In 2021, the periods with regulation shortfall ranged between 3MW and 22MW, this was narrower than 2020 which recorded regulation shortfall between 17MW to 40MW.

COMPETITION IN THE GENERATION AND RETAIL MARKETS

Annual Market Share by Generation Company 2017–2021 (Based on Scheduled Generation)



* Embedded generators exclude TP Utilities.
Note: The percentages in this chart may not add up to 100% due to rounding.

Shifts in the three leading generation companies

In 2021, Keppel Merlimau Cogen overtook YTL PowerSeraya to join Tuas Power Generation and Senoko Energy as the three leading generation companies. The combined market share of these three leading generation companies (Keppel Merlimau Cogen, Tuas Power Generation and Senoko Energy) shrank 2.5 percentage points to 50.5 percent in 2021. Tuas Power Generation's market share shrank 2.4 percentage points to 17.7 percent, its smallest market share since the market started. Senoko Energy and Keppel Merlimau Cogen's market share grew 0.4 percentage point and 0.5 percentage point to 18.2 and 14.6 percent respectively.

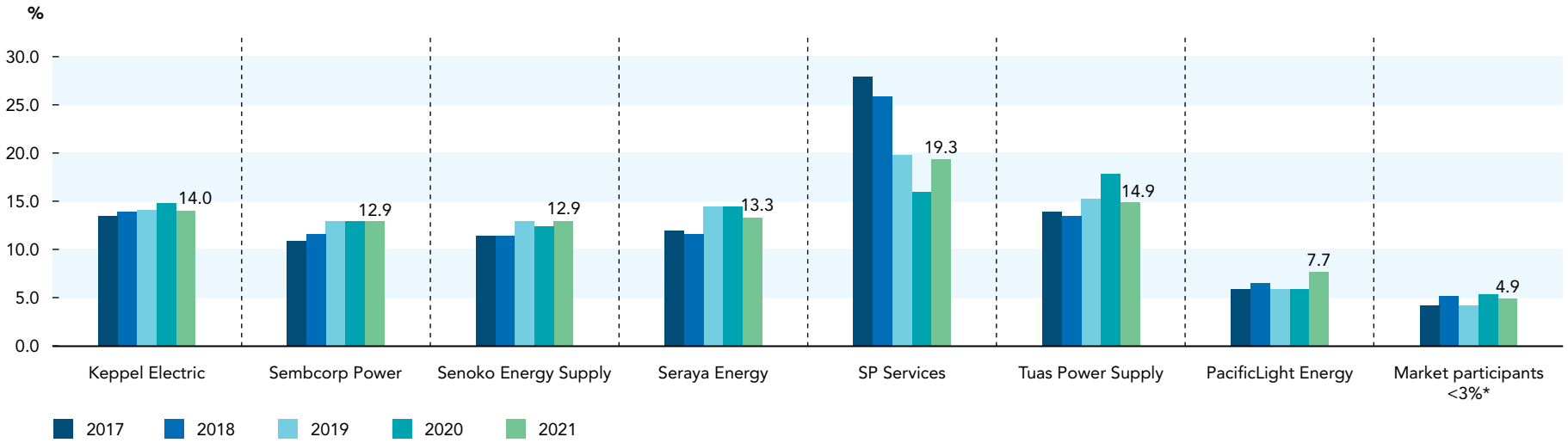
Amongst the other generation companies, YTL PowerSeraya's market share contracted 1.6 percentage points to 13.5 percent – its smallest market share since the market started. Tuaspring's market share grew the most, by 1.2 percentage points, followed by Sembcorp Cogen, PacificLight Power and TP Utilities whose market shares rose 1.0 percentage point, 0.9 percentage point and 0.1 percentage point respectively.

The market share of EGs contracted 0.3 percentage point while that of the incineration plants expanded 0.1 percentage point.

MARKET PERFORMANCE:

COMPETITION IN THE GENERATION AND RETAIL MARKETS

Annual Market Share of Market Support Services Licensee and Retailers 2017–2021 (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, I Switch, Just Electric, MyElectricity, Ohm Energy, SilverCloud Energy, Sunseap Energy, UGS Energy and Union Power.

Note: The percentages in this chart may not add up to 100% due to rounding.

Market share of smaller retailers decrease with the exit of independent retailers

In the Open Electricity Market (OEM), the consumption of residential consumers who have switched from SP Services to retailers and 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.

Competition cooled in the second half of 2021 as four independent retailers exited the market. As a result, SP Services held the largest market share. Among the larger retailers[12], Keppel Electric, Seraya Energy and Tuas Power Supply took the top three positions.

The market share of SP Services grew 3.2 percentage points to 19.3 percent. Apart from SP Services, PacificLight Energy and Senoko Energy Supply's market shares expanded 1.7 percentage points and 0.5 percentage point to 7.7 percent and 12.9 percent respectively. The market shares of Tuas Power Supply, Seraya Energy and Keppel Electric shrank 3.0 percentage points, 1.3 percentage points and 0.8 percentage point to 14.9 percent, 13.3 percent and 14.0 percent respectively. Sembcorp Power's market share remained unchanged at 12.9 percent.

The market share of the 'Market participants <3%' category shrank 0.4 percentage point to 4.9 percent. This category comprises retailers with a market share of less than 3.0 percent each.

12 Excludes consumers who purchase from SP Services.

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 2021

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)[13]. In 2021, EMC issued a total of 30 margin calls.

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 2021, EMC issued 19 default notices[14]. Arising from these events of default, 31 first default levy notices were issued, 17 of which were made good by drawing from the defaulting MP's credit support. Due to insufficient credit support for the remaining 14 first default levy notices, the non-defaulting market participants were apportioned a share of the default levy. A total of $506,061.55 was levied upon the non-defaulting market participants.

Automatic Financial Penalty Scheme (AFPS) and Minimum Stable Load (MSL) Compensation Scheme — 1 January to 31 December 2021

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 was to incentivise the GRFs to comply with 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 2021, there were 54 periods when the AFPS kicked in, including 22 periods for a deviating LRF. The total penalty collected was $558,186.77. 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 2021, $56,839.87 was paid out for a total of 33 periods under the MSL compensation scheme. The amount paid out was funded by the market via the monthly energy uplift charges.

13 With effect from 8 January 2020, the risk exposure threshold to trigger a margin call has been reduced from 70 percent across the board to 55 percent for MPs and 60 percent for the MSSL.
14 A default notice is issued to a defaulting market participant up till the market participant is suspended.

MARKET PERFORMANCE:

CONTRACTED ANCILLARY SERVICES

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

From 1 April 2021 to 31 March 2022, 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 $11.43 million for the period from 1 April 2021 to 31 March 2022. The capability was sourced from YTL PowerSeraya, Senoko Energy, Tuas Power Generation, and Keppel Merlimau Cogen.

Contracted Ancillary Services — 1 April 2021 to 31 March 2022

Contract Period	Cost of Ancillary Services	Total MW Contracted
1 April 2021 to 31 March 2022	$11,427,243.05	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 2021 to 30 June 2022

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)	0.3491

PSO Fixed Fees – 1 July 2021 to 30 June 2022

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

PSO Net Fees – 1 April 2021 to 31 March 2022

PSO Net Fees ($'000)	25,171

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.

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.

default levy
The levy imposed by the EMC to recover the payment shortfall due to any MP's default in making payment. The default levy is apportioned to all non-defaulting MPs in proportion to their absolute net invoice amount.

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 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.

distributed energy resources (DER)
Electricity-producing resources or controllable loads that are connected to a local distribution system or a host facility within the local distribution systems. In Singapore's context, examples of DER include solar panels, electricity storage and controllable loads. These resources are typically smaller in scale than the traditional generation facilities that serve most of Singapore's electricity demand.

embedded generators (EG)
Generation units that generate electricity to their on-site load principally for self-consumption.

event of default
The failure of an 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 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 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 LNG vesting quantity allocated.

LNG vesting quantity
With the start of the 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 who has an electricity licence issued by the EMA and has been registered with EMC as a market participant to trade in the wholesale electricity market.

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

ADDITIONAL INFORMATION:

GLOSSARY

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

open electricity market (OEM)
An initiative by the 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. 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.

reserve
Stand-by generation capacity or interruptible load that can be drawn upon when there is an unforeseen disruption of supply.

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 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. EMC's settlement system uses the VCHP to settle the vesting quantity between the MSSL and the generation companies.

withdrawal energy quantity (WEQ)
This is measured in megawatt hour and refers to the amount of electricity withdrawn by load facilities. It is provided by the MSSL, SP Services.

wholesale market
The transactions made between generation companies and retail companies.

Notice and Disclaimer

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