

SINGAPORE FORWARD CAPACITY MARKET

# High-Level Design Straw Proposal

PREPARED FOR



*Smart Energy, Sustainable Future*

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# I. Overview of Market Design

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The Energy Market Authority of Singapore (EMA) is proposing a Forward Capacity Market (FCM) to address concerns in the current Singapore Wholesale Electricity Market (SWEM). The SWEM is designed as an energy-only market (EOM) with ancillary services. Generation companies are remunerated primarily based on prevailing half-hourly spot prices for energy generated. By design, the EOM seeks to provide short term price signals to guide longer term investments in generation capacity. However, there is no guarantee that the EOM will achieve timely resource adequacy to ensure electricity supply reliability. The experience in many jurisdictions with EOMs is that wholesale electricity spot prices that result from the prevailing demand and supply conditions may not be high enough on average over the longer term to attract sufficient new investment in generation capacity to meet the target reliability standard (or corresponding reserve margin).

Other jurisdictions with similar concerns in their EOMs have implemented FCMs to ensure that resource adequacy is met. The concept is to express the resource adequacy target as demand for capacity in a forward auction, and let suppliers compete to meet that demand at the lowest price. In combination, the real-time wholesale energy and ancillary services markets, and FCM, aim to meet the following objectives:

- Maintain resource adequacy by providing adequate incentives to existing resources and new investment; and
- Maximize economic efficiency to minimize long-run costs to consumers.

The product definition in an FCM is simply a MW of capacity supply obligation: to be available and to offer into the energy market, for a year, subject to penalties for failing to perform. Broadly, the three main components of the market are: (1) a demand curve for capacity, (2) the rules defining how supply participates and forms a supply curve, and (3) the format of the auction in which supply and demand come together to determine which resources clear and the prices they are paid.

**Demand for capacity** expresses how much capacity to buy as a function of price—in effect, a set of demand bids each expressed in dollars per megawatt (MW) of capacity arrayed in descending order, just like demand curves in any economics textbook. However, unlike most markets, the FCM demand curve is developed administratively by the system operator to buy enough capacity to meet the target reliability standard (or corresponding reserve margin). The curve is designed to avoid procuring substantially more capacity than needed and to allow prices to rise to attract new resources when supply becomes scarce relative to the target reserve margin. The demand curve is therefore centred near the target reserve margin, at a benchmark price given by the net Cost of New Entry (Net CONE). It slopes rapidly upward to the left in shortage conditions, and downward to the right in surplus, low-cost conditions. The slope may reflect the declining marginal value of capacity, or it can be less steep to mitigate price volatility. Another demand curve issue to address is how the target quantity relates to the load forecast

and any special treatment of large new discrete loads that are difficult to forecast and enter with relatively short notice.

In order to maximise competition and innovation to meet resource adequacy needs at least cost, the **supply participation rules** should be non-discriminatory. No particular resource type should be favoured by the market design over another resource, provided that they are both capable of providing the same marginal resource adequacy value to the market. Each participating resource provides an offer in terms of dollars per MW of **qualified capacity**, and all offers are stacked in ascending order to form the **supply curve**.

Offers may be mitigated to protect against the exercise of market power. Market power is endemic to capacity markets (and to energy markets during tight supply conditions) because available supply typically exceeds demand by small margins, such that even medium-sized suppliers could withhold capacity profitably, unless required to offer competitively. Competitive offers would reflect resources' net avoidable going-forward fixed costs after considering net revenues from selling energy and ancillary services (and clean energy attributes, if any).<sup>1</sup>

The auction itself brings together the ascending supply and the descending demand curve in order to clear the market. The auction clears at the point where the supply and demand curves intersect. That clearing point determines which resources clear and take on a capacity supply obligation, i.e. all those with offers at or below the clearing price. Those that clear typically take on a capacity supply obligation for one year, and they earn the clearing price for that single year.

The capacity auction must take place prior to the delivery period, although jurisdictions vary considerably in how far ahead they conduct the auction. A three-/four-year forward period is typical, corresponding to the lead time for constructing a new combined cycle gas turbine (CCGT). This enables potential new generation to compete with existing generation. Such advance commitment also resolves uncertainties regarding the potential retirement of existing supply in time for new generation to replace it. Subsequent to the forward auctions, reconfiguration auctions would be held nearer to the Delivery Year to efficiently address changes in demand or supply availability.

Our initial proposal for each market design element in the FCM is presented in Table 1. Each element is discussed in more detail in the subsequent sections.

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<sup>1</sup> It is important to note that mothballing or retiring a generation unit may not avoid all fixed costs. For example, a take-or-pay fuel contract may be considered a fixed cost that cannot be avoided by a retirement or mothball decision. In addition, property taxes and some insurance may be unavoidable for plants that mothball. Overall, any costs that are unavoidable would not vary depending on whether the plant stays online, and the capacity payment does not need to cover those costs in order to be willing to stay online.

**Table 1: Overview of Preliminary FCM Design Straw Proposal**

| Market Design Element   | Preliminary Design Straw Proposal   | Remarks  |
|---|---|--|
| <b>Product Definition</b>   | <ul style="list-style-type: none"> <li>• 1 MW-year of unforced <b>Capacity Supply Obligation (CSO)</b>; “unforced” is derated for availability, as addressed below.</li> <li>• A CSO entails a must-offer requirement in the energy market whenever available (i.e. not on outage), subject to penalties for being unavailable or otherwise not performing during peak or shortage periods.</li> </ul>  | <ul style="list-style-type: none"> <li>• Product definition must correspond to the MW “demand” for resource adequacy.</li> <li>• Product must have clear obligations.</li> </ul>   |
| <b>Administrative Demand Curve</b>  | <ul style="list-style-type: none"> <li>• <b>Downward-sloping demand curve</b> with minimum acceptable reliability at the price cap, then sloping downward to the right; shape tuned to reflect relative marginal reliability value or to achieve acceptable reliability/price outcomes under an assumed Net Cost of New Entry (CONE).<sup>2</sup></li> <li>• <b>Price cap</b> at or above estimated Net CONE to account for estimation error.</li> <li>• <b>Update CONE</b> on a X-year review cycle. Implement annual updates based on a formulaic approach. <b>Update annually the (expected) net revenues received from the energy and ancillary services markets.</b></li> </ul>  | <ul style="list-style-type: none"> <li>• The objective is to meet the resource adequacy requirement.</li> <li>• A downward sloping demand curve reduces price volatility, and recognizes some incremental value of capacity.</li> <li>• Cap must be high enough to express higher marginal value at low reserve margins, to mitigate the possibility of underestimating true Net CONE, and to shift the distribution of reserve margin (RM) outcomes rightward without paying high prices for excess capacity.</li> <li>• Net CONE parameters need to be adjusted to market conditions.</li> </ul> |
| <b>Supply Curve (including Resource Qualification and Offer Mitigation)</b> | <ul style="list-style-type: none"> <li>• <b>Technology-neutral</b> design to qualify all resources that can contribute to resource adequacy, including demand response, imports, efficiency, storage; both existing and planned.</li> <li>• <b>Qualified “unforced” MW ratings (UCAP)</b> adjust for outage rates, intermittency, and energy-limits.</li> <li>• <b>Market Power Mitigation</b> <ul style="list-style-type: none"> <li>– All existing resources must offer.</li> <li>– Screen suppliers to detect supply-side market power, and mitigate offers of those that fail (to net going-forward costs).</li> <li>– Do not apply minimum offer price.</li> </ul> </li> <li>• <b>Supply curve</b> aggregates all supply offers (subject to mitigation) in ascending order.</li> </ul> | <ul style="list-style-type: none"> <li>• Technology-neutral approaches will maximize efficiency, competition, and innovation.</li> <li>• “UCAP” is a uniform product, with all MW competing to provide the same marginal reliability value.</li> <li>• Market is structurally uncompetitive with pivotal suppliers. <ul style="list-style-type: none"> <li>– Must-offer requirement and mitigated offers prevent supply-side market power abuse.</li> </ul> </li> </ul>  |
| <b>Forward Capacity Auction</b>   | <ul style="list-style-type: none"> <li>• <b>Uniform price auction</b>, all cleared suppliers earn the same price.</li> <li>• <b>Single round, sealed bid</b> auction.</li> <li>• <b>Four-year forward period.</b></li> </ul>  | <ul style="list-style-type: none"> <li>• Uniform price, single-round, sealed-bid auctions maximize competition; has a proven record of delivering efficient market outcomes.</li> </ul>  |

<sup>2</sup> Net CONE is an administrative estimate of the long-run marginal cost of capacity (\$/MW-year) from the generation technology most likely to enter the market. It includes capital recovery plus the fixed and variable operating costs of a new resource, minus (expected) net revenues received from the energy and ancillary services markets.

| Market Design Element                                   | Preliminary Design Straw Proposal  | Remarks   |
|---|--|---|
|   | <ul style="list-style-type: none"> <li>• Single-year commitment.</li> </ul>  | <ul style="list-style-type: none"> <li>• Multi-year lock-in for new resources discriminates against and distorts incentives to maintain existing resources.</li> </ul>  |
| <b>Reconfiguration Auctions</b>                         | <ul style="list-style-type: none"> <li>• <b>Reconfiguration auction(s)</b> conducted between the forward period and delivery, e.g., at T-1.</li> <li>• <b>Supply offers</b> would include: <ul style="list-style-type: none"> <li>– Any capacity without existing supply obligation from base auction.</li> <li>– Any excess capacity procured by central buyer in base auction that is not needed with updated (lower) load forecast.</li> </ul> </li> <li>• <b>Demand bids</b> would include: <ul style="list-style-type: none"> <li>– Any incremental needs by the central buyer to meet updated (higher) load forecast.</li> <li>– Any capacity with a CSO that wishes to buy out of that obligation.</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>• Provides an opportunity to adjust capacity commitments with demand changes and changes in availability.</li> </ul>   |
| <b>Bilateral Transactions</b>                           | <ul style="list-style-type: none"> <li>• Enable buyers and sellers to engage in voluntary bilateral contracts.</li> <li>• Enable post-auction exchange of CSOs.</li> </ul>   | <ul style="list-style-type: none"> <li>• Support market participants in managing their own risks and uncertainties.</li> </ul>  |
| <b>Supply Obligations and Performance Incentives</b>    | <ul style="list-style-type: none"> <li>• Suppliers are obligated to demonstrate availability consistent with their obligations, and face penalties consistent with under-performance.</li> <li>• Penalty rates will be high enough to incentivise performance (but not so high as to impose undue costs that discourage participation).</li> </ul>   | <ul style="list-style-type: none"> <li>• An appropriate penalty system will ensure capacity obligations are appropriately fulfilled and supply is available during shortage conditions.</li> </ul>  |
| <b>Settlements and Cost Allocation</b>                  | <ul style="list-style-type: none"> <li>• Costs allocated to customers based on their contribution to system peak(s).</li> <li>• Costs of serving each demand bid in the base and reconfiguration auctions would be allocated to the relevant demand.</li> </ul>  | <ul style="list-style-type: none"> <li>• System peak(s) drive the need for capacity, so cost allocation should reflect contribution to that peak(s).</li> </ul>   |
| <b>Reforms to Energy and Ancillary Services Markets</b> | <ul style="list-style-type: none"> <li>• <b>Mitigate energy offers to Short Run Marginal Cost (SRMC).</b></li> <li>• Consider <b>alternative or additional ancillary services (AS).</b></li> </ul>   | <ul style="list-style-type: none"> <li>• Emulates a perfectly competitive market; no need to allow exercise of market power (and associated inefficiencies) since FCM supports recovery of fixed costs.</li> <li>• Expressing marginal value of energy and AS incentivizes efficient operations and investment.</li> <li>• Additional ancillary products, if necessary, provide revenues to resources that supply AS needed for reliable operations.</li> </ul> |

## II. Product Definition

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The product definition specifies exactly what each resource in the market is obligated to provide if it clears the auction. Consistent with the concept of “capacity”, the product should be 1 MW of capacity supply obligation (CSO) for a year. A CSO requires the resource to offer its full available capacity into the energy (and/or ancillary services) market in every interval, subject to penalties for unavailability and non-performance during peak or shortage hours.

As a refinement, each “MW” of capacity transacted can represent not a MW of nameplate capacity, but a derated capacity that has as much reliability value per MW as capacity that is always available. The derate accounts for each resource’s outage rates, intermittency, and any energy limits. The derated capacity naturally forms the basis for any availability/performance penalties, although the full capacity available at any given time must be offered into the energy market. With this approach, one MW from any qualified resource would provide the same expected value. This creates a uniform product for which all resources can compete fairly, be compensated equally, and be accounted for appropriately when setting system capacity targets. Other jurisdictions refer to the derated capacity as “unforced capacity” or “UCAP”.

Capacity products could be more multi-faceted and varied to specify certain sub-products with specific characteristics (such as quick-start capacity), locational products, seasonal or time-of-day products, or multi-year products. The preliminary proposal adopts the simplest approach, which is to define an annual UCAP MW product with no locational requirement and no additional specifications, over a one-year delivery period.

This relatively simple, single-product proposal is suitable for the supply and demand dynamics in Singapore’s electricity market:

- Locational products are likely unnecessary because instances of binding transmission constraints are rare in the SWEM. This will be determined at later stages of the design process.
- Seasonal products are unnecessary because load and supply resource availability does not differ greatly by season.
- The option for multi-year commitments is worth considering as it has the effect of reducing investment risk.

If certain resource characteristics are absolutely needed to operate the system, one option is to specify the need for them as sub-products in the capacity market. But if those characteristics are merely more valuable or convenient than substitutes (such as fast-start vs. spinning reserves) then we recommend recognizing that value only in the ancillary services markets and/or in capacity ratings,<sup>3</sup> rather than specifying sub-products for capacity. This avoids inefficiently biasing the resource mix and complicating the mechanics for resource qualification.

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<sup>3</sup> Section IV below describes how capacity ratings could account for resources’ operating limitations.



### III. Administrative Demand Curve

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The capacity demand curve is set administratively, and it is designed to procure enough capacity to meet forecasted peak load plus the required reserve margin needed to meet reliability requirements.

The simplest option would be to procure a fixed quantity using a vertical demand curve at the target reserve margin. However, a vertical demand curve leads to significant capacity-price volatility, is susceptible to the exercise of market power, and does not recognize the gradual change in marginal reliability value as reserve margins vary. Our straw proposal for Singapore is therefore that the administrative demand curve be downward-sloping.

The following sections describe the proposed demand curve parameters, from the demand forecast and target reserve margin to the price cap and the shape of the curve.

#### A. Demand Forecast

The demand forecast should include all forecastable load. The EMA already has established load forecasting methodologies that it will continue to apply for the purposes of FCM.

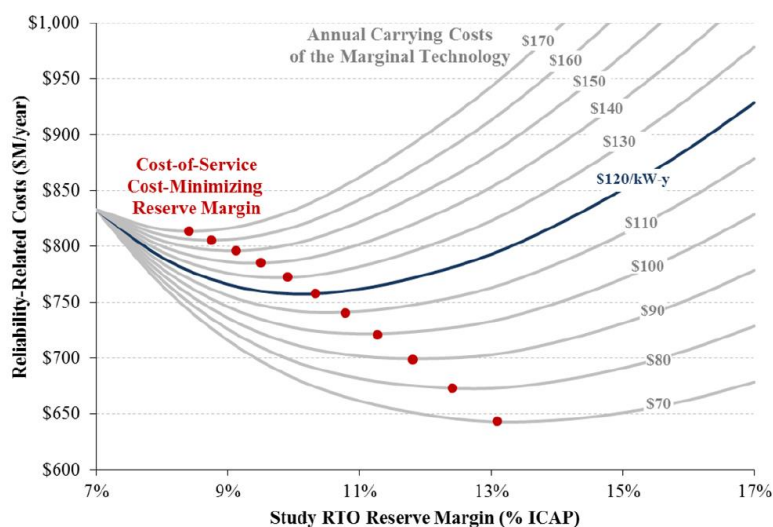
In addition, the FCM design may consider holding back some forward demand from the base auction to be procured in subsequent reconfiguration auctions if there is reason to believe that some short-lead time supply would not be able to commit to participation in the base auction but would be available in the reconfiguration auctions. This could be an efficient way to accommodate load forecast uncertainty and the addition of short-lead time capacity resources.

#### B. Target Reserve Margin and Other Objectives

The default would be to continue using the existing reliability standard to determine the minimum required reserve margin over the load forecast; the FCM would have to procure at least that reserve margin.

The reliability standard could be defined to reflect an economically optimal reserve margin via a cost-benefit analysis weighing the cost of capacity against the benefits of reduced load shedding (analyzed probabilistically), reduced emergency actions, and more efficient dispatch. The optimal reserve margin depends on the marginal cost of capacity. When the marginal cost of capacity is higher, a lower reserve margin would be optimal and deemed acceptable, and vice versa, as illustrated in Figure 1 below. The “optimum” reserve margin might be based on a best estimate of CONE (and a downward-sloping demand curve centered on that point would appropriately clear more or less, depending on the cost, as discussed below).

**Figure 1: Total Costs as a Function of Reserve Margin and CONE**  
with risk-neutral economically optimal reserve margin indicated by red dot



Source: Pfeifenberger, Hannes, K. Spees, K. Carden, and N. Wintermantel, "Resource Adequacy Requirements: Reliability and Economic Implications," Prepared for the Federal Energy Regulatory Commission, September 2013.

The design of the capacity demand curve will reflect not only the capacity procurement target but two other design objectives to support a well-functioning market:

- **Low Price Volatility:** The curve should be designed to mitigate price volatility and the abuse of market power. Flatter demand curves will support these objectives by limiting the price impacts from small shifts in supply or demand. For example, a very flat curve would result in only a modest price increase even if a large amount of supply were withheld.
- **Regulatory Stability:** To support a well-functioning market where investors can form expectations based on market fundamentals and a clear understanding of the rules, the parameters used to derive the demand curve should be rational, stable, and transparent.

These demand curve design objectives may be in opposition at times, especially quantity assurance (not too high and not too low) vs. price stability. Different markets prioritize different objectives.

## C. General Approaches to Demand Curves

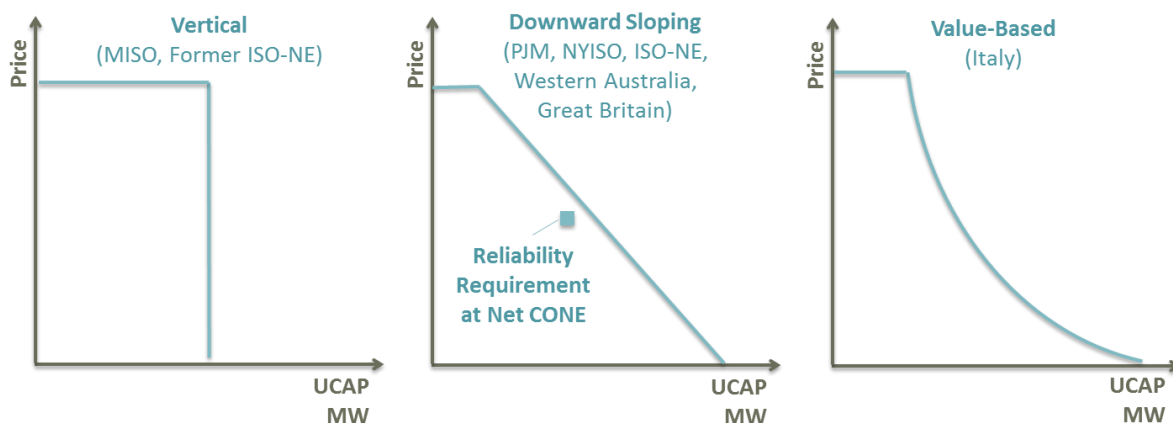
The three main approaches to designing a demand curve are described below and illustrated in Figure 2.

1. **A Vertical Demand Curve** establishes the exact quantity of capacity that is needed based on the reliability standard. The advantage of a vertical demand curve is that it is simple, but that simplicity comes at the expense of introducing greater price volatility and potential for exercise of market power.<sup>4</sup>

<sup>4</sup> The high price volatility and exposure to market power are both driven by the fact that small changes in quantity (whether on the supply side or demand side) can result in a large change in price. These and other disadvantages drove ISO-NE to switch to a downward-sloping demand curve.

2. **A Downward-Sloping Demand Curve** is designed around the reliability requirement and estimated long-run sustainable prices at the net cost of new entry (Net CONE), as depicted schematically below (actual shapes vary by jurisdiction). Downward-sloping curves mitigate the price volatility experienced with a vertical demand curve but introduce some quantity uncertainty. The balance between price and quantity certainty can be managed by adjusting the slope and shape of the curve.
3. **A Marginal Value-Based Demand Curve** is based on a probabilistic analysis of marginal system costs at varying reserve margins. At each reserve margin, the analysis estimates the value of lost load, the cost of emergency actions, and production costs. From that cost function, one can derive the demand curve as the marginal change in cost per MW of change in reserve margins. The shape of such a curve is convex to the origin, with diminishing marginal value as reserve margins increase.

**Figure 2: Approaches to Determining Capacity Demand Curve**



The appeal of the marginal value-based curve is that it is grounded in economic value, and it enables the FCM to maximize economic efficiency. It can procure the economically optimal quantity of capacity, clearing a higher optimum reserve margin under conditions where the marginal cost of capacity is low (when there is excess supply or there are low-cost sources of new capacity); or it will clear at a lower optimum reserve margin when capacity is scarce.

However, a marginal value-based curve does not necessarily meet traditional reliability standards. A combination of this approach with the “Downward-Sloping curve to meet reliability standards” takes the shape of the marginal value-based curve but scales it to meet traditional standards. The resulting curve is proportional to marginal reliability value and thus pays the same amount of money per incremental improvement in reliability no matter what the reserve margin. This is essentially the approach taken in ISO-NE.<sup>5</sup>

## D. Demand Curve Parameters for Singapore

The best demand curve for Singapore depends on Singapore’s unique objectives and context. The demand curve should be designed to meet Singapore’s minimum reliability standard. The

<sup>5</sup> The locational demand curves for parts of New England are shifted to meet certain deterministic reliability criteria, and this corrupts the relative-marginal-value attributes of the curve.

top of the curve (at the price cap, as discussed below) would be set at the reserve margin corresponding to the minimum reliability standard. The curve could slope downward from there based on the relative marginal reliability value, as described above. Singapore's marginal reliability value curve could be determined using the same probabilistic model that is used to translate the reliability standard into a required reserve margin.<sup>6</sup>

In addition, capacity market simulation analyses can play a central role in informing the design of the demand curve, as they have in other jurisdictions. Monte Carlo simulations that account for supply and demand curves—and empirically-based fluctuations thereto—can be used to estimate the distribution of reserve margins and prices any candidate demand curve would likely deliver.<sup>7</sup> The results can guide refinements to the curve. For example, if the simulated volatility is unacceptably high (or if the price simply increases too sharply with the removal of a single generator) the curve could be straightened and stretched rightward. Or if simulated reserve margins fall below the minimum by an unacceptably high percentage of the time, the price cap could be raised and/or the curve could be stretched rightward. The trade-off with right-stretching the curve is that it will shift the distribution of likely auction outcomes to higher reserve margins. Average reserve margins could exceed the minimum by several percentage points.

These issues will have to be resolved in the next stage of the design process. The primary aspects and parameters of the demand curves to consider are:

- **Net CONE:** Except possibly in value-based demand curves, the pricing points on a downward-sloping demand curve are typically established as some multiple of either the gross or net cost of new entry (CONE). Net CONE is an administrative estimate of the long run marginal cost of capacity from a reference resource based on the generation technology most likely to enter the market; it includes capital recovery plus the fixed and variable operating costs of a new resource, minus (expected) net revenues received from the energy and ancillary services markets. Net CONE can be estimated in a review cycle with an independent consultant every few years (exact frequency to be

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<sup>6</sup> Evaluating the model at a range of candidate reserve margins yields the LOLH as a function of reserve margin. The change in LOLH for each incremental unit of capacity (that is the first derivative of this function) gives the marginal reliability value of capacity at each reserve margin. Finally, the demand curve would be priced, based on the marginal reliability value at each reserve margin, proportionally to the assigned price at the minimum reserve margin.

<sup>7</sup> See the following examples in PJM, ISO-NE, and IESO:

Newell et al., *Fourth Review of PJM's Variable Resource Requirement Curve*, filed by PJM, located here: <https://www.pjm.com/directory/etariff/FercDockets/3814/20181012-er19-105-000.pdf>.

*Testimony of Dr. Samuel A. Newell and Dr. Kathleen Spees on Behalf of ISO New England Inc. Regarding a Forward Capacity Market Demand Curve*, located here: [http://www.nepool.com/uploads/Filing\\_20140401\\_ER14-1639\\_Demand\\_Curve.pdf](http://www.nepool.com/uploads/Filing_20140401_ER14-1639_Demand_Curve.pdf).

Spees et al., *ICA Demand Curve Development: Proposed Approach for Ontario*, stakeholder presentation, located here: <http://www.ieso.ca/-/media/Files/IESO/Document-Library/engage/ica/ica-20180124-demand-curve-analysis.pdf?la=en>

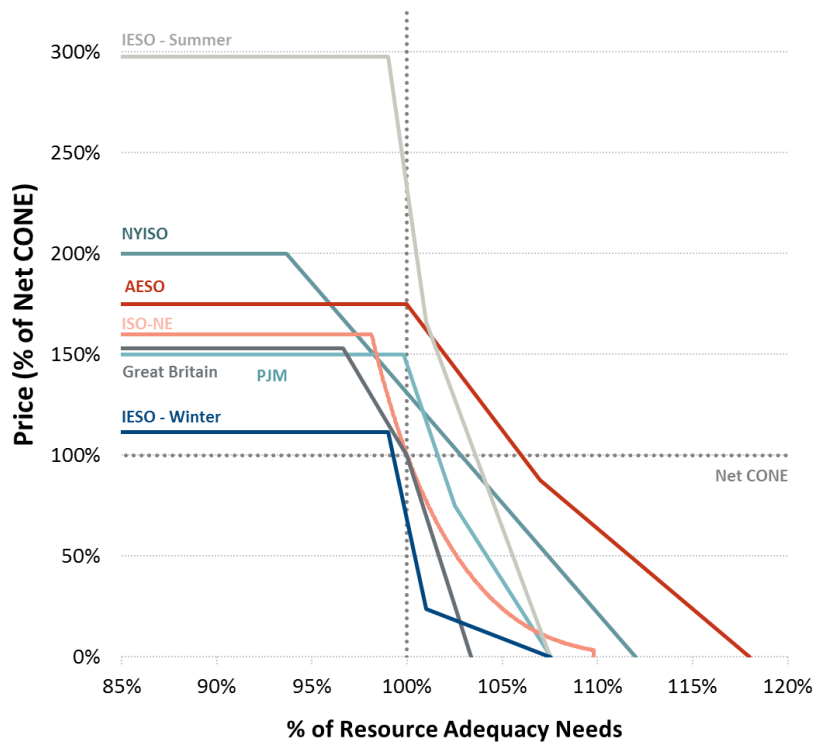
determined).<sup>8</sup> That exercise focuses on identifying the appropriate reference technology, estimating its capital costs and annual fixed costs, levelizing the capital costs to a first-year “total capital recovery requirement” given reasonable assumptions on the cost of capital and on future revenues, then subtracting estimated net of revenues from the energy and ancillary services markets (and any other revenues the marginal entrant may expect). The net revenue analysis should be updated annually since market prices for fuel and energy can change more rapidly than the cost of new plant.

- **Price (and Quantity) at the Cap:** One of the most important determinants of how a capacity market demand curve will perform is the price and quantity at the price cap. Selecting a price cap requires striking a balance between: (a) objectives to reduce price volatility and susceptibility to market power exercise, both of which are served by lowering the price cap; and (b) objectives to provide strong price incentives to maintain reliability during shortage periods and limit the number of events at low reliability levels, which are better served by increasing the price cap. In addition, the price should reach the cap at a quantity equal to or greater than the “minimum acceptable” quantity. We will continue to evaluate the uncertainties in Net CONE to determine the appropriate price cap.
- **Shape and Slope of the Demand Curve:** The price cap combined with the overall shape and slope of a demand curve will determine the range of price and quantity outcomes that can be realized from the market. Each shape implies a certain distribution of price and quantity outcomes, which can be simulated, as noted above. Higher price caps also have a large effect in increasing price volatility given the steepness of capacity demand and supply curves. Defining the exact demand curve parameters is an exercise in balancing trade-offs, and selecting from among a range of workable options. Figure 3 illustrates the shapes and slopes of the demand curves used in most international capacity markets. Note that the curves with gentler slopes will provide non-zero prices even at higher levels of cleared reserves.

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<sup>8</sup> Net CONE is typically updated annually based on an index formula, which will be elaborated in future drafts of the HLD. The same review conducted to determine CONE will also estimate the energy and ancillary services (E&AS) profit margins for the reference resource. The profit margins for the reference resources will determine the E&AS offset, which will be subtracted from gross CONE to determine Net CONE. A methodology for estimating E&AS margins will need to be developed in the run up to FCM implementation and reviewed once every few years (typically three or four) after the FCM begins.

**Figure 3: Comparison of Demand Curves**



### Next Steps

Revisit reliability objective, to reflect economically optimal reserve margin.

Determine initial Singapore demand curve parameters (auction price cap as function of Net CONE, quantity at cap, shape, and slope of the demand curve); final determination in detailed design will include determination of Net CONE and impact analysis of a range of potential combinations of demand curve parameters to inform reliability and price volatility trade-offs.

## IV. Supply Resource Qualification and Capacity Ratings

A resource qualification process is needed to validate that supply resources participating in the auction will be online and able to operate in the delivery year. Resource qualification also determines the MW value each resource may offer into the auction, given its demonstrated availability and operating limitation. This step is needed both to ensure that resources are compensated fairly and consistently with their value, and to ensure sufficient capacity is procured in the auction to meet resource adequacy requirements.

## A. Qualification Requirements

Capacity suppliers will need to meet certain obligations, like credit requirements or construction milestones, to be allowed to sell capacity in a base or reconfiguration auction. These milestones are necessary to establish that resources have a sufficiently strong likelihood of being physically available to provide capacity in the delivery year. The focus of these requirements is primarily on planned resources; existing capacity resources are generally assumed to be eligible for all future years unless submitting plans to retire or mothball.

Our preliminary proposal for qualification requirements for each resource type are summarized in Table 2. The qualification requirements trade-off strong forward certainty and visibility for the system operator against excess barriers and participation costs by requiring milestones that do not fit with the commercial reality of the resource’s development timeframe. Qualification requirements are tailored to specific resource types, considering their various lead times and commercial realities. The EMA will need to develop technical term sheets or requirements to formalize how resources present their qualifications for participation in the FCM.

**Table 2: Preliminary Qualification Requirements by Resource Type**

| Type  | Options and Preliminary Recommendations   |
|---|---|
| <b>Existing Generation (Thermal, Solar, etc.)</b> | <ul style="list-style-type: none"> <li>Minimal requirements, e.g. to attest to no plan to retire or mothball to meet credit requirements (to demonstrate they could replace themselves if needed).</li> </ul>   |
| <b>Planned Generation (Thermal, Solar, etc.)</b>  | <ul style="list-style-type: none"> <li>To credibly demonstrate that they can enter service by the delivery year, planned generation must demonstrate sufficient development progress (e.g., site ownership, permits, and interconnection studies/approval) and planned milestones (e.g., construction contracting, construction milestones, and testing).</li> <li>In addition, suppliers must make a (possibly non-refundable) security deposit and demonstrate sufficient credit to fund replacement capacity if they fail. Timely determination of failure depends on subsequent monitoring of progress against agreed plans/milestones.</li> <li>The specific requirements could vary by asset type, and assets with longer construction periods could be required to show additional progress on milestones before qualifying. These requirements would be developed through coordination with stakeholders and based on a review of recently-developed plants.</li> </ul> |
| <b>Planned Uprates</b>                            | <ul style="list-style-type: none"> <li>Relatively few requirements may be needed on a four-year forward basis, other than possibly submitting a description of the proposed uprate. Shorter-term reconfiguration auctions would require the uprate to have already been completed or have documentation of the contracted and scheduled retrofit dates (similar to requirements for planned generation).</li> </ul>   |
| <b>Imports</b>                                    | <ul style="list-style-type: none"> <li>External resources must guarantee dedication to Singapore by demonstrating that their home market has no call on the resource even during shortage conditions.</li> <li>They must also establish deliverability by securing the necessary firm transmission capacity within the home market to the border, and from the border into Singapore.</li> </ul>  |
| <b>Planned Demand Response (DR)</b>               | <ul style="list-style-type: none"> <li>Security and credit requirements similar to planned generation, but otherwise less specified since DR providers may not know all of their end-use assets four years in advance. Require a credible business plan to acquire customers, and milestones for acquiring them (as in other FCMs).</li> <li>Require a description of the nature and MW quantity of DR, including any call limits (number, duration, or both) for the portfolio.</li> <li>Criteria for reconfiguration auctions may be more concrete, including demonstration of contracts.</li> </ul>  |

## B. Determination of Qualified Capacity

The approach for determining the amount of qualified capacity from each resource should be consistent with the principle of resource neutrality: 1 MW of capacity should have the same reliability value (i.e., value in decreasing expected unserved energy) across all resource types, accounting for their different characteristics through their ratings.

For dispatchable resources, capacity ratings will reflect each resource's ability to generate when needed for reliability, accounting for forced and unplanned outages. As long as the outages can be considered random and not strongly correlated among resources, it is appropriate to set the capacity rating at 100% minus the outage rate. Outage rates for existing resources can be taken from history; for new resources that have no historical data, generic values based on OEM specifications and/or historical performance of similar units could be assumed.

For intermittent resources, the capacity rating should similarly reflect the resource's expected availability when needed for reliability. A key difference from dispatchable resources is that intermittent generating resources' availability depends on insolation (or solar) patterns, so they cannot be reliably dispatched to avert shortages. One option for determining capacity value is to estimate the capacity factor during peak hours. However, this simple approach may not accurately represent the availability during other hours that could experience shortages. And it does not account for the natural correlations across similar resources. An emerging and improved approach is to probabilistically estimate the marginal reliability value of an intermittent resource. This is often described as the amount of incremental peak load that could be supported by an incremental MW while maintaining the same level of reliability, or the "effective load carrying capability (ELCC)". A closely related concept is the marginal reliability value of the resource compared to that of an always-available resource.<sup>9</sup> One can estimate ELCC using the same probabilistic model used to estimate loss-of-load hours. Probabilistic approaches may be preferred as more renewable resources are added and their correlated output variations become larger in aggregate. For example, it is widely accepted that the ELCC of particular resource types such as solar will tend to decline as the penetration level increases.

The approach for qualifying demand response (DR) must reflect the underlying resources' inherent characteristics. Important considerations include:

- Maximum potential DR during different system conditions (e.g. times of day);
- Capacity derate for availability, which may be class averages for new resources or unit-specific based on historical 3- to 5-year average performances during true calls or during test calls;
- A gross-up in capacity value associated with avoided transmission and distribution losses;
- Coincidence in availability of a particular DR type with peak needs; and
- Call-hour limitations, which may require a capacity derate if the call limits are very restrictive.

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<sup>9</sup> See International Renewable Energy Agency, [Planning for the Renewable Future: Long-Term Modelling and Tools to Expand Variable Renewable Power in Emerging Economies](#), p. 34.



The initial proposal for how qualified capacity will be determined for each resource type is presented in Table 3. Note that new resources that lack historical data may be assigned default deratings and may be subjected to tests to assess their performance. Even existing resources that have rarely been dispatched may need to be subjected to performance tests.

**Table 3: Preliminary Determination of Qualified Capacity by Resource Type**

| Type  | Preliminary Recommendations   |
|---|---|
| <b>Dispatchable Generation</b>              | <ul style="list-style-type: none"> <li>• Installed capacity rating minus the expected forced + unplanned outage rate (EFORd).</li> <li>• Expected outage rates based on 3 to 5-year historical average outage rates.</li> <li>• New resources have resource type averages applied for first 3-5 years.</li> </ul> |
| <b>Intermittent Generation (Solar/Wind)</b> | <ul style="list-style-type: none"> <li>• Option 1. Probabilistically estimate the system capacity value as discussed above.</li> <li>• Option 2. Use historical 3-5 year average of capacity factor during peak hours.</li> </ul>   |
| <b>Demand Response</b>                      | <ul style="list-style-type: none"> <li>• Require supplier to demonstrate capacity value, accounting for frequency of the call option on the resource and alignment of call options with peak hours.</li> </ul>  |
| <b>Imports</b>                              | <ul style="list-style-type: none"> <li>• Derates above apply based on resource types.</li> <li>• Additional derates applied to account for transmission system contingencies and constraints on the importing transmission system.</li> </ul>   |

## C. Rules for Imported Capacity

Should there be imported capacity in future, imported resources will need to demonstrate a firm commitment and ability to deliver power to the market. In addition to resource-specific qualification requirements as discussed above, additional requirements will be placed on external suppliers to ensure that each MW of capacity imports transacted in the FCM has the same system reliability value as internal capacity.

External resources that wish to sell into the FCM would need to provide evidence that they will supply capacity when needed, even if their home market is in shortage.<sup>10</sup> They will also need to demonstrate that they have adequate transmission capabilities to deliver power into the Singapore market for the amount of capacity they wish to sell. Details of how imports demonstrate these commitments will build on the existing frameworks in Singapore for energy imports.

## D. Credit Requirements for Participation

Credit requirements will be established for all resource types to ensure they are financially capable of covering replacement capacity purchases and/or non-delivery penalties if and when necessary.

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<sup>10</sup> For example, PJM has stringent requirements for external capacity resources. Requirements include proof of long-term firm deliverability from the unit to the border of PJM, proof of generation deliverability within PJM through “Network External Designated” transmission service, and proof that the unit meets the same criteria as capacity resource in PJM via the execution of an “External Resource Must Offer Agreement”. See [PJM Manual 18 Section 4.2.2](#) for details.

## Next Steps

Develop detailed UCAP rating methodologies for determination of qualified capacity; will include calculation of unit-specific and class-average unforced outages across resource types, within Singapore and for imports.

For planned resources, define required permitting/construction milestones to participate in base and reconfiguration auctions, and planned milestones to monitor for timely detection of development failures. Also establish credit requirements and possible security deposits to protect the system from development failures.

In the detailed design phase, develop technical term sheets or requirements to formalize how resources present their qualifications for participation in the FCM.

## V. Market Power Monitoring and Mitigation

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All capacity markets are considered structurally uncompetitive at least some of the time because residual supply tends to be small (with little excess beyond peak load plus reserve margin) relative to the size of some suppliers. Singapore is no different, with several suppliers being large enough to be pivotal or become pivotal as excess capacity diminishes. Large participants could have the incentive and ability to increase the price by inefficiently withholding capacity. Withholding could occur physically (e.g. not offering or early retirement of a resource), or economically (by offering a resource at a price above the cost of providing capacity with the intention of not clearing the auction).

FCM can protect against the exercise of market power through market power monitoring and mitigation. The measures will address both physical and economic withholding. To address physical withholding a must-offer requirement for all resources will be implemented. Resources that wish to retire, mothball, or export their capacity will need to receive a must-offer requirement exemption from the market administrator prior to the auction in order to do so. The decision to grant a must-offer requirement exemption will be reviewed by the EMA to test for potential market power abuse.

To prevent economic withholding, the FCM will cap (“mitigate”) the auction offer prices of market participants that are deemed likely to have both the incentive and ability to exercise market power. To determine which capacity suppliers will have their offers capped, the FCM will employ a market power screen to test each supplier. There are many different types of market power screens used in other jurisdictions, such as the three-pivotal supplier test, the single-pivotal supplier test, the conduct and impact test, or an incentive test.<sup>11</sup> Each of these

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<sup>11</sup> PJM uses a Market Structure test based on a three-pivotal supplier test. If the required capacity cannot be met with the output of the two largest suppliers, plus the output of the supplier being

screens has advantages and disadvantages, and can result in a larger share of suppliers being mitigated. The appropriate market screen for FCM will depend on the objectives of regulators and the market administrator in Singapore, as well as the market concentration, shape of the demand and supply curves, and other factors that can affect the likelihood of market power abuse. Details will be determined at later stages of the design process.

Suppliers with market power need not have all of their offers mitigated. Defining a “no-review” threshold can reduce the administrative burden of mitigation and can limit the risk of over-mitigating. Such thresholds can represent a reasonably low estimate of the net going-forward costs of providing capacity, either generically or by resource type. The specific levels will be determined in the detailed design.

Resources that fail the market power screen and exceed the no-review threshold would be subject to possible mitigation. To enforce that their offers are competitive and reasonably reflect net going-forward costs, the FCM will provide the resources with two options:

1. Submit a pre-determined default offer cap (typically the same as the review threshold).
2. Request a resource-specific offer cap and provide cost and revenue data to support the request. The data will be reviewed and used to calculate a resource-specific offer cap, consistent with the net going-forward cost of that resource.

Auction results will also be reviewed ex post to detect any potential exercise of market power.

The exercise of buyer-side market power does not appear to be a concern in Singapore, so we do not propose rules to address it. Nor are there dominant retailers with large short positions beyond four years that might motivate them to introduce uneconomic capacity to suppress the price.

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tested, then all three are jointly pivotal. These three suppliers would be able to manipulate prices by jointly withholding output. See PJM Tariff Attachment DD: Reliability Pricing Model, Section 6.3. We have previously raised the concern that this test is too stringent as it would mitigate even very small suppliers; see Reitzes et al., “Review of PJM’s Market Power Mitigation Practices in Comparison to Other Organized Electricity Markets,” September 2007.

NYISO uses similar monitoring and mitigation measures, based on a single pivotal supplier test. Of particular interest are several measures that are specifically applied only to market-internal import-constrained capacity zones, particularly New York City which has a high concentration of both supply and demand. These factors tend to increase the risk and impact of market power exercise relative to larger and more structurally-competitive capacity zones. See NYISO Tariff Attachment H: Market Power Mitigation Measures, Section 23.2.1.

MISO’s monitoring and mitigation measures are quite different from those in PJM and NYISO, partly because of the region’s traditionally-regulated market structure in which the vast majority of supply and demand are represented by vertically-integrated, cost-of-service-regulated utilities that have balanced positions and so have little incentive to manipulate capacity auction prices. In that context, and to minimize its interference in the auction, MISO imposes mitigation measures only if it determines that exercise of market power could increase auction clearing prices by an impact threshold of at least 10% of the Cost of New Entry (CONE). In that case, must-offer or offer-cap mitigation measures may be applied. See MISO Tariff Module D, Section 64.2.1(e).

### Next Steps

Develop market monitoring protocols for supply-side market power. Will include determination of appropriate market power screening test, based on analysis of factors that may affect likelihood of market power abuse and clarification of regulators' objectives.

Detailed design will establish technology-specific benchmark costs to use as offer review thresholds and mitigated default offers.

## VI. Forward Capacity Auction

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The straw proposal for the FCM is to have a twelve-month commitment term with a four-year forward auction. The forward auction will have a uniform clearing price paid to all resources, conducted as a single-round auction, with sealed bids. This auction structure will maximize reliability at the lowest possible societal cost, and has a strong performance record in other capacity market contexts.

### A. Auction Design, Offer Format, and Price Setting

We recommend a single-round, sealed-bid, uniform clearing price auction. This is the auction structure that is most likely to achieve efficiency and deliver the targeted reliability at the lowest cost. The initial proposals on auction design elements are as follows:

- **Uniform price vs. pay-as-bid.** We recommend that the FCM auction be a uniform price auction. In this construct, all cleared suppliers receive the same price. The main advantage is that suppliers have the incentive to offer at cost (the absolute minimum price they are willing to accept to provide capacity, i.e., at their net going-forward costs), except in cases of market power.<sup>12</sup> As a result, the clearing price in the auction generally reflects the marginal cost of capacity, which is most likely to ensure least-cost procurement of capacity and provides efficient long-term signals for investment and consumption.

In an alternative pay-as-bid approach, all cleared suppliers are paid their bid price. Theoretically, these two approaches could produce the same prices if suppliers accurately estimate the marginal cost of capacity. However, in practice, the pay-as-bid

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<sup>12</sup> Competitive offers at net going-forward costs would include: (a) capital and fixed costs incurred in the immediate year, minus (b) energy/ancillary margins expected in the immediate year, minus (c) future net capacity and ancillary margins expected for the remainder of the asset life. If the capacity obligation exposes suppliers to non-performance risk, the rational offer price would not drop below the expected penalty size.

construct will likely not achieve the efficient price signals achieved by uniform pricing. The pay-as-bid construct may lead to gaming by market participants (sellers have an incentive to offer at a price just below the highest expected auction clearing price, although no lower than their net going-forward costs), which will make monitoring for the abuse of market power difficult. In particular, suppliers with a larger generation portfolio are likely to have more information about the potential clearing price, and would be at an advantage compared to smaller suppliers who risk guessing the clearing price wrong and inefficiently fail to clear their resource.

- **Uniform vs. differentiated payments for new and existing capacity.** While differentiating payments between existing and new resources could save customers money overall and also send a stronger/higher price signal for new investments when needed, price differentiation can potentially be inefficient as it reduces competition and induces inefficient retirement of lower-cost existing resources.

It will be important to ground this discussion in a more complete assessment of the societal and customer cost implications of price differentiation in both the near term and long term before deciding on this design element.

- **Single round vs. multi round.** Our proposal is for the FCM auction to be single round. Multi-round auctions are used to allow resources to amend offers during the auction clearing process. However, such auctions can be more complex to administer and increase the risk of participants engaging in gaming behaviour.
- **Open bid vs. sealed bid.** Market participants in the FCM will submit sealed bids. In a sealed bid auction, the offers of the participants are not revealed to the other participants during the auction. The additional information made available to participants via open bidding may introduce greater opportunities for gaming. This shortcoming has led all existing capacity auctions to use the sealed bid approach.
- **Auction clearing and price setting.** The FCM auction clearing price will represent the intersection of the supply curve, made up of all the supply offers into the auction, and the demand curve.<sup>13</sup>
- **Offer format.** Our initial proposal is that resources can submit up to 10 offer segments, which can each be rationable (can partially clear) or non-rationable (“lumpy”). Higher priced segments will not clear unless lower-cost segments clear first. Lumpy segments will be guaranteed all-or-nothing clearing.

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<sup>13</sup> The mechanism for auction clearing and price setting will need to be developed further as we continue to design the FCM. There are different approaches to auction clearing, such as maximizing social surplus, minimizing of costs, or based on a set of heuristics. These approaches generally approximate the intersection of supply and demand but accommodate the complexities introduced by lumpy and segmented resource offers. This will include the development of procedures for tie-breaking cases. Auction clearing procedures will be transparent and shared with all market participants.

## B. Commitment Term

The commitment term refers to length of time a resource is committing to provide capacity by participating in the market. For example, under a single-year commitment term, a resource that clears the auction would be obligated to provide capacity for a pre-determined 12-month delivery period in the future.

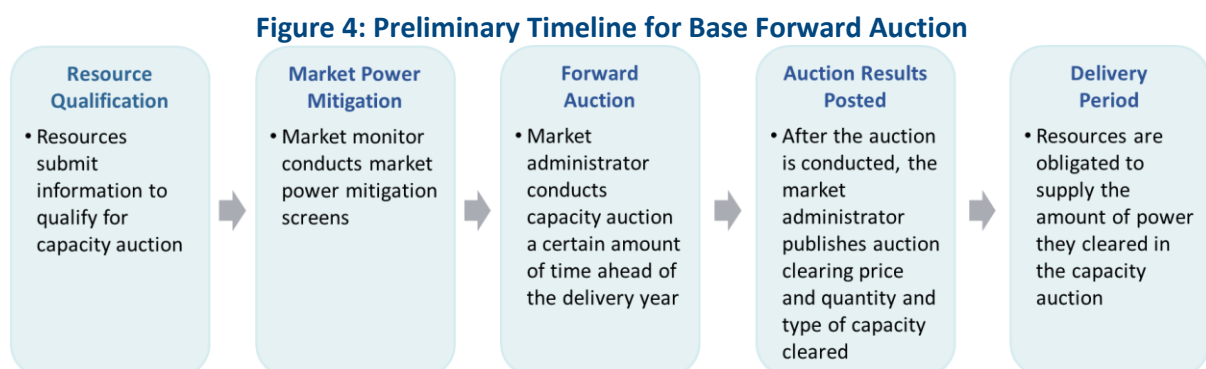
Our preliminary recommendation is that Singapore implement a single-year commitment period. A purely multi-year commitment term for all resources would discriminate against resources that cannot commit to provide capacity many years into the future, such as demand response or older resources approaching retirement.

Our preliminary proposal is that Singapore not implement a multi-year lock-in of prices for new resources. The reasons for this are:

- A multi-year lock-in for new resources discriminates against existing resources, and distorts the incentives for generation owners. With the option for a multi-year lock-in on new resources, generation owners will have less incentive to invest in maintaining existing resources and more incentive to build new resources, even if maintaining existing resources is the lower-cost option for providing capacity to the market. This will result in higher capacity costs for customers, with no additional reliability benefits.
- Singapore has a stable regulatory environment, so new generation should be able to trust that regulators will allow markets to work and future prices will reflect market fundamentals. That puts investors in a position to be able to invest when it is economic to do so, or not if they perceive real doubts about the long-term value of a particular resource. Special provisions to incentivize new investment may therefore be unnecessary, and they could be distortionary if they reduce investors' incentives to carefully assess future market conditions.

## C. Auction Timelines

The FCM market rules will establish the timing of events leading up to the auction, immediately after the auction, and for the period between the auction and the delivery period. These procedures are illustrated in Figure 4.



**Pre-auction:** During the pre-auction period, the market administrator will need time to qualify resources, and the market monitor will need time to implement market power mitigation procedures (see Section V on market power mitigation). Other jurisdictions begin these

processes 5-8 months before the auction. The responsible institutions in Singapore will need to assess how much time is required to conduct these functions, and establish the timelines appropriately.

**Post-auction:** After each auction, the results should be published in a timely manner, usually within a few weeks. The published auction results should, at a minimum, include information on the clearing price, how much capacity cleared, and what types of resources cleared. The lag time allows the market monitor to assess auction performance to check for ex-post signs of market power abuse or other inefficiencies, before publishing the results of that assessment. On longer time scales, the overall performance of the FCM should also be assessed, potentially by an independent third party, after every few years (perhaps more frequently at the beginning of FCM implementation).

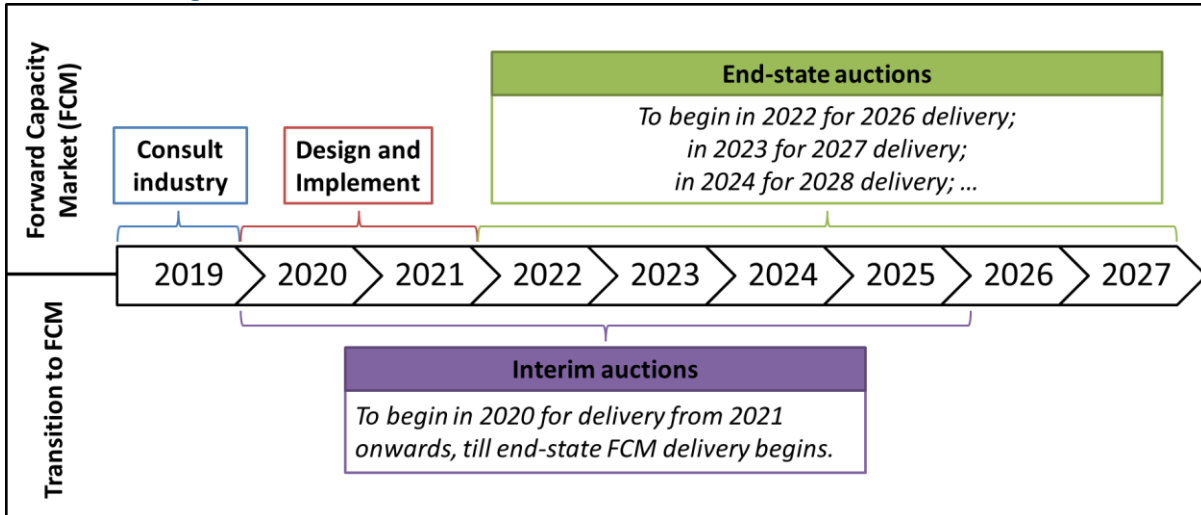
**Forward period:** The forward period refers to the time between the auction and the start of the delivery period. We recommend a four-year forward period to align with new resource development timelines in Singapore. Implementing a longer forward period increases the uncertainties that exist between the auction and delivery of capacity, which has several adverse effects for market participants and the market administrator. For suppliers of capacity, a longer forward period increases the risk associated with their capacity obligation. Capacity owners will have to estimate the cost of maintaining capacity during the forward period, and predict whether or not their resources will be available many years into the future. This will likely disfavour DR and existing resources, in favour of new resources. The increased uncertainty is likely to reduce the supply offered into the auction and drive up clearing prices, which implies a higher cost of capacity for electricity customers. For the market administrator, a longer forward period implies more uncertainty around forecasting the amount of capacity needed during the delivery period. In order to maintain the target level of reliability, the market administrator will need to procure larger amounts of capacity, which will also have the effect of costs for customers.

To ensure timely execution and facilitate a smooth transition from the current EOM to an energy-plus-capacity market, transitional ‘interim’ auctions are proposed to be held from mid-2020 for delivery from 2021 onwards.<sup>14</sup> Figure 5 contains the indicative timeline for the transitional ‘interim’ auctions timeframe and the progression into the standard ‘end-state’ FCM base auctions.

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<sup>14</sup> Interim auctions are envisaged to operate on simplified design parameters to allow for rapid implementation. Results from these auctions will also provide insights to inform the progressive development and implementation of the ‘end-state’ FCM auctions.

Figure 5: Indicative Timeline for Interim Auctions and FCM Auctions<sup>15</sup>



## VII. Reconfiguration Auctions

Reconfiguration auctions are designed to address the uncertainty (both demand-side and supply-side) between when the base auction occurs and when the delivery period starts. On the demand side, the load forecast may change, which will affect how much capacity the EMA needs to procure. On the supply side, resources' availability may also change, necessitating a mechanism to allow resources with a CSO to buy out of previously committed positions (and transfer the CSO to another qualified supplier).

The preliminary recommendation is to conduct one or more reconfiguration auctions between the base auction and the delivery period. The proposal is to have a four-year forward period, with the last reconfiguration auction about 12 months prior to delivery. The timing of the reconfiguration auctions and base auctions (for different delivery years) can be staggered to prevent having to conduct multiple auctions in a short time period.

The FCM market rules must establish the format and participation model of the reconfiguration auctions:

- **Auction Format and Demand Curve:** Our proposal is that the same auction format apply as in the base auctions. In addition, while auction parameters may be updated, we recommend that the demand curve shape in the reconfiguration auction otherwise be unchanged from the forward auction. Any systematic discrepancies in auction format or curve shape and position have the potential to create incentives for suppliers to arbitrage between these auctions to capture the value differential between these curves. The nature of the potential arbitrage play will depend on market conditions.
- **Auction Clearing Mechanism:** There are two possible clearing mechanisms in reconfiguration auctions: gross clearing and net clearing. Under the gross clearing

<sup>15</sup> Length of the forward period for auctions is subject to further review.



mechanism, all supply and demand in the market are represented in the auction. The demand curve shape is the same as in the base auction, providing for a clear way of seeing the effect of updated auction parameters on the administrative demand curve. Under the net clearing mechanism, only supply and demand that is incremental to the base auction is represented. This means that buy-out bids appear on the buy side, as expected. Our initial proposal is to implement the same clearing approach as in the base auction (gross clearing), and combine it with a settlement on a net basis (i.e., only the incremental cleared quantities would be settled at the reconfiguration auction price). This allows market participants that do not wish to change their position to be unaffected by the reconfiguration price.

- **Supply Resources Offers and Bids:** During the reconfiguration auctions, market participants may want to change their capacity commitments because of changes in resources' availability or performance rating. To allow for these types of adjustments, the initial proposal is that market participants will be allowed to submit the following types of offers and bids:
  - **Incremental Sell Offers:** Enable suppliers to offer in additional capacity that has been made available or capacity that requires a shorter lead time (e.g. demand response and imports).
  - **Buy-out Bids:** Enable suppliers to buy out of their committed positions (for financial reasons or because they are no longer able to provide the capacity, e.g., construction is lagging behind schedule).
  - **Do Nothing:** Enable capacity suppliers who do not wish to change their supply to participate as a price taker on the supply side during the reconfiguration auctions. This will not incur any settlement as a result of the auction (if the auction is settled on a net basis).

## VIII. Bilateral Transactions

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The FCM will be a “gross market” in which all of the supply and demand are physically verified and cleared, while supporting market participants' interest to transact bilaterally. Bilateral buyers and sellers can transact to hedge the costs as they wish. The market administrator can provide information to facilitate bilateral contracting, both before and after the auctions.

## IX. Supply Obligations and Performance Assessments

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Supplier receiving a CSO will be subject to a “must-offer” obligation that requires them to offer into the energy market. In addition, they may have other obligations such as participating in

performance testing and data collection activities necessary to calculate qualified capacity levels. Specific offer and testing requirements for capacity resources, which may vary by resource type, should be developed.

Performance assessments indicate how compliance with obligations will be measured, and associated penalties/bonuses determine how such compliance will be incentivized. The consideration includes the combined set of incentives from energy market and potential penalty/bonus mechanisms associated with the capacity product, which can best encourage efficient operations and investment. Our straw proposal is that efficient incentives can be imposed through capacity performance/incentives that mimic energy shortage pricing.

## A. Obligations on Capacity Resources

Obligations on the capacity product procured during the capacity auction has to be properly defined. As a starting point, we suggest the following as best practices when adapting the must-offer requirement to apply to different resource types:

- **Must-Offer Requirements.** Apply the must-offer requirement in order to ensure the full availability of committed resources and mitigate the potential for exercise of market power. However, allow alternative means of fulfilling must-offer requirements for certain resources if the cost or practicality of requiring them to be fully dispatchable might disqualify or under-utilize significant quantities of valuable resources. For example, demand response could be incorporated under a standing strike price arrangement (if they wish to avoid the costs associated with full telemetry and 30-minute dispatch).
- **Must-Offer Quantities.** Require committed generators to offer at the installed capacity (ICAP) equivalent of their qualified capacity rating whenever they are not on outage, and impose similar requirements on other non-traditional resources.
- **Must-Offer Hours and Availability Windows.** Impose must-offer requirements in all hours across the delivery period, but allow for the possibility that some resource types may not be available outside of certain windows that are specific to that resource type. For such types of resources, require them to offer whenever they are available and adjust their qualified capacity ratings downward if availability window limitations materially reduce their delivered capacity value.

In addition to the must-offer requirement, the existing arrangements for capacity resource outage planning and reporting should continue. Planned and maintenance outages should be scheduled to ensure sufficient capacity is available when needed, especially in key peak demand periods; reporting of unplanned outages will inform updates to qualified capacity levels (UCAP derates) and assessment of performance penalties (if applicable, see following section).

## B. Penalties for Resource Unavailability

Incentives for resource performance during shortage conditions can come both from the energy market and from the capacity market. We recommend energy market prices reflect marginal system costs, including scarcity and the costs of administrative actions during shortage conditions, up to the energy market price cap.

Capacity performance incentives and penalties are important to encourage performance and solidify the value of the capacity product:

- **Availability and Performance Incentives.** Several markets have established penalty and/or credit mechanisms that measure suppliers' availability during pre-defined hours of the year and/or performance during shortage conditions. The purpose of an availability mechanism is to reward sellers for maintaining availability for dispatch to the system operator, especially during times when the resource is most likely to be needed for supply adequacy. As a starting point, we suggest to apply availability-based penalties to incentivize reliability of resources that have been committed through the capacity auction. Performance penalty mechanisms encourage strong in-year performance from resources and readiness to respond to dispatch instructions.
- **Penalty Rate.** The total size of potential penalties needs to be large enough to encourage delivery of the promised capacity, but should not be so burdensome as to reflect a cost far beyond the value of the underlying capacity. The penalty payment can be developed considering a few options such as:
  - Tying the penalty rate to the original capacity price (e.g., a penalty rate at 1.2 to 1.5 times the capacity price), which caps the overall magnitude of the penalty payment and associated risk at some reasonable fraction of the potential reward;
  - Imposing a floor on the penalty rate that would apply in circumstances when capacity market prices are low;
  - Imposing a minimum penalty at some factor above the clearing price in the last incremental auction before delivery, which would ensure that deficient suppliers have an incentive to procure replacement capacity; or
  - Setting the penalty at the capacity auction price cap or some factor above it, again creating incentives to secure replacement capacity if any is available.

### Next Steps

Develop penalty payment terms (e.g., penalty rate level and potential differentiation of penalty rates based on timing); will involve analysis of potential capacity shortfalls and evaluation of associated penalties under different penalty mechanism designs.

## X. Settlements and Cost Allocation

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Our preliminary recommendation is that settlement occur monthly. Each capacity supplier would be paid the auction clearing price for each MW UCAP capacity for which they received a capacity obligation, minus any penalties assessed.

These costs will be allocated to customers based on customer demand during peak load hours, which could be a fixed number of system-coincident peak hour(s) or a pre-defined set of hours

that is aligned with peak. The number of hours to include in this allocation must be determined in later analysis and will reflect the number of hours that have non-negligible outage probabilities (a flatter load shape would imply that more hours are close to peak and should be included). More importantly, the cost allocation mechanism should be designed to reflect cost causation, i.e. how each customer contributes to the need for capacity.

Costs will be allocated to customers, through retailers or load serving entities (rather than through a non-bypassable charge), to allow retailers to offer innovative ways to pass these costs on to consumers, hedge capacity costs or demand volume, and others. Specific cost allocation to customers will have to be tracked on a per-customer basis, so that costs will follow end customers even if they change retailers.

### Next Steps

Determine the details of the cost allocation approach, including the number of hours that will be considered in allocating costs to consumers. We will analyze peak load hours and shortage events to develop a recommendation for the appropriate number of days or hours to consider.

## XI. Reforms to Energy and Ancillary Services Markets

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The introduction of an FCM can be complemented by changes to the existing energy and ancillary services markets to ensure the combined markets function efficiently.

First, because FCM provides for recovery of fixed costs, resources' energy offers can be mitigated to their short-run marginal costs. This emulates a perfectly competitive energy market and allows the market to always clear the resources with the lowest costs.

Second, alternative or additional ancillary services are recommended if operations assessments indicate that some system needs are not currently met reliably. For example, if ramping supply is found to be in short supply during certain conditions, a flexible ramp product could be introduced to provide a revenue stream to suppliers that can provide valuable ramping (note that this is unlikely to be the case today with the current generation mix).

### Next Steps

Discuss approach to energy and ancillary services markets reforms, including consideration of approaches to address environmental sustainability and lower carbon emissions.

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