Review of Alternative Electricity Procurement Processes for the Provision of Delmarva Power's Standard Offer Service

Final Report & Recommendations

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Prepared for

The State of Delaware Public Service Commission Staff

by

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Acronyms

ARR	Auction Revenue Rights
BRA	Base Residual Auction
CCGT	Combined Cycle Gas Turbine
CMI	Continuous Modeling Initiative
CP	Capacity Performance
CPP	Clean Power Plan
DA	Day Ahead
DR	Demand response
FRS	Full Requirements Service
FTR	Financial Transmission Rights
IRP	Integrated Resource Plan
ISO	Independent System Operator
LEI	London Economics International
LMP	Locational Marginal Price
LSE	Load Serving Entity
MMU	Market Monitoring Unit
NPV	Net Present value
PLC	Peak Load Contribution
PPA	Power Purchase Agreement
PSC	Public Service Commission
REC	Renewable Energy Credit
RFP	Request for Proposals
RPM	Reliability Pricing Model
RSCI	Residential and Small Commercial & Industrial
RT	Real Time
SOS	Standard Offer Service

1 Executive Summary

In April 2015, London Economics International ("LEI") was retained by the Staff of the Delaware Public Service Commission ("PSC" or "Commission") to undertake a review of Delmarva Power and Light Company's ("Delmarva") current Standard Offer Service ("SOS") supply procurement approach, consider potential alternative options for SOS procurement going forward, and present recommendations. This report, the final in a series of papers and presentations, lays out LEI's findings and recommendations.

1.1 Summary of LEI's analysis and deliverables to date

LEI's September 2015[1] report (the "September 2015 Report") in these proceedings included a review of SOS (or equivalent) procurement processes in comparable jurisdictions. The report also introduced and discussed the characteristics of four electricity supply procurement methods:

1. Purchases from the spot market;
2. Full Requirement Service contracts;
3. Long-term contracts; and
4. Building/Owning own generation.

LEI's submission of the September 2015 Report was followed by a technical conference and comment period, which allowed stakeholders to comment on LEI's findings. LEI took note of all comments and expanded this discussion of alternative supply procurement methods to include topics commented upon by the interveners, which included the ability of the SOS provider to operate generation resources, or actively manage a procurement portfolio, to ensuring that SOS rates are consistent with the underlying wholesale market prices so as to enable the development of a competitive retail market.

1.2 Overview of DPL's current SOS procurement

Delmarva's current Residential and Small Commercial & Industrial ("RSCI") procurement method relies on three year, fixed price Full Requirement Service ("FRS") contracts and a laddered procurement approach. For the 2015-2016 solicitation, the amount of FRS supply sought was approximately 250 MW, representing one third of the RSCI SOS load.[2] Since the FRS contracts are fixed price and suppliers are responsible for a given percentage of the SOS load, this approach allows the SOS provider to transfer all risks associated with load variation and

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[1] LEI, *Review of Alternative Electricity Procurement Processes for the Provision of Delmarva Power's Standard Offer Service: Task 1 – Electricity Supply Procurement Assessment*, Docket 14-0283, September 23, 2015.

[2] Overview – 2016 Delmarva Power Delaware SOS RFP. <http://www.pepcoholdings.com/about-us/do-business-with-phi/energy-suppliers/wholesale-suppliers/delmarva-power-delaware-sos/overview/>

price variations to the FRS suppliers. This transfer of risk from the SOS provider to the FRS suppliers, however, comes at a cost. LEI has calculated that historically, on average, FRS suppliers have embedded in their offer a risk premium corresponding to approximately $10/MWh, or 11% of the supply offer price.[3]

1.3 Evaluation of alternative supply procurement processes

Order No. 8619 by the Delaware PSC in Docket No. 14-0283 specified that LEI's recommendation should discuss "*whether such an approach will lead to lower energy supply costs over the long-term*". In addition to lowering the costs of supply for SOS customers, LEI has also considered four other evaluation criteria introduced in the September 2015 Report when developing its recommendations, which are:

1. Efficiency and consistency with competitive markets, or the likelihood of procurement results to be comparable to those in competitive wholesale markets for the products being purchased;
2. Balancing benefits and costs to ensure the least cost to consumers, such that the procurement process is transparent, supports competition, minimizes risks, and results in least cost to consumers (commensurate with risks);
3. Consistency with overall Delaware policies, which emphasize reliability of supply and stable prices at the lowest possible cost; and
4. Ease of Implementation, to evaluate the levels of regulatory requirements or administrative burden(s) and costs for the SOS provider.

1.4 Findings and recommendations

When purchasing power directly from the spot markets, the SOS provider bears all risks associated with the year-over-year variability of wholesale market prices. As such, while this approach would satisfy the evaluation criteria such as transparency, consistency with the competitive markets, or ease of implementation, the level of inherent variability of wholesale market costs is not consistent with the desire for stable supply costs. Moreover, this would not balance effectively the benefits to consumers, such as lower costs, with the risks associated with variability of supply costs resulting from spot market purchases.

LEI's review and analysis has shown that changing FRS contract procurement parameters such as contract length, block size, procurement period, or auction mechanism would not significantly impact SOS supply costs if FRS contracts remain the primary means of procuring supply.

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[3] LEI researched forward prices for FRS supply components over the three year term of the contracts at the time the auctions were held, and compared these values with the actual results from the auction in order to estimate a risk premium. The analysis is detailed in Appendix B (Section 8.2.1)

Another alternative supply procurement method that LEI analyzed is the procurement of supply through long-term contracts. These contracts would allow the SOS provider to secure a fixed amount of energy and capacity at a given price, thus providing stable costs of supply. The procurement of supply for a majority of the load through long term contracts (supplemented by purchases from the spot markets for load following) would also satisfy the evaluation criteria such as transparency and ease of implementation. However, conversely to purchases from the spot markets, this approach would emphasize price stability to the detriment of consistency with the current market conditions. As a result, the risks due to load variations would be borne by the SOS provider. Such an approach would not be in the best interest of RSCI SOS customers.

Finally, LEI does not recommend the option of having the SOS provider build or purchase its own generation assets, given the relatively small size of RSCI SOS load as well as the risks involved in owning and operating a generation source. The SOS provider would not benefit from economies of scale afforded to owners of large generation portfolios.

In order to seek potential optimization of the supply procurement methodology so as to provide lower supply costs while providing acceptable variability, and satisfy the other evaluation criteria, LEI analyzed potential supply portfolios, each combining a certain percentage of supply from various procurement methods.

LEI's analysis shows the merits of a portfolio approach, which can result in a lower cost of supply, with respect to the current FRS procurement method. Portfolios, however, will impact the variability of supply, as well as potentially increase the administrative requirements for the SOS provider. The composition of the portfolio can affect the relationship between decreased supply costs and the corresponding increase in variability of supply costs. While LEI did not consider every possible portfolio composition, the analysis of alternative procurement methods suggests that a portfolio composed of 30% two year FRS contracts, in addition to contracted supply equivalent to approximately 60% of the remaining SOS load (or 42%[4] of the overall supply requirement),[5] with the remaining supply procured through spot market purchases, is potentially the most appropriate option among those combinations that were evaluated. Such a portfolio would result in lower expected costs of supply when compared to the current SOS procurement approach (i.e., FRS). The portfolio procurement method, however, would also result in a moderately higher variability of supply costs when compared to FRS procurement, as well as increase the administrative requirements for the SOS provider.

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[4] Considering FRS contracts accounts for 30% of supply, 60% of the remainder supply requirement corresponds to 42% of overall supply requirement (60% times 70%).

[5] Using the load forecast from Delmarva's 2014 IRP, the contracted quantities would correspond to 140 MW of around-the-clock energy contracts and 400 MW of capacity contracts.

Should the PSC decide to pursue a portfolio approach, additional modeling and testing may be necessary to refine the optimal risk-adjusted portfolio such that it provides lower expected average supply costs with an acceptable level of variability and price risk. Furthermore, with time, it might be reasonable to readjust the ratios of each procurement method within the portfolio so as to maintain an optimal balance of risk and cost of supply.

In the suggested portfolio, two year fixed-price FRS contracts would cover 30% of the supply requirement while 10 year fixed price, fixed quantity contracts would cover 60% of the remaining load, or 42% of the total supply requirement. Purchases from the spot market would represent the remaining 28% of the total supply requirement. The combination of long-term energy contracts and purchases from the spot market together with FRS contracts is expected to result in a lower average cost than an all-FRS contracts approach. While the average variability of the portfolio would be larger, it would be well below that of supply purchased entirely from the spot markets. Based on simulation modeling representing LEI's view on the most likely outcome (given current market knowledge), the recommended portfolio is expected to be approximately $7/MW, or 8% less expensive than the forecast expected costs of the FRS procurement option.

The tradeoff for this approach is an increase in the variability of supply costs by an average of approximately $2/MWh over FRS contracts procurement. However, the resulting average increase in variability of supply costs of LEI's proposed portfolio approach would still be lower than the reduction in average supply costs. In fact, the increased variability can be considered a benefit by allowing SOS rates to follow the wholesale market prices more closely, thus facilitating the emergence of competitive retailers.

LEI's proposed portfolio best satisfies the evaluation criteria set forth to evaluate the alternative procurement methods. In addition to lower average supply costs when compared to the current FRS procurement method, the predetermined proportions of supply from the various procurement methods in the portfolio would allow for transparency and linkage to competitive markets, while minimizing the active portfolio management burden for the SOS provider. Delmarva would likely not need to acquire market analysis or trading resources as hedging of market prices would be provided through the procurement of FRS and long term contracts. The procurement of supply through the PJM spot markets or competitive solicitations would further ensure that results are competitive. This portfolio also ensures mitigation of the load variation risk as well as the price risk by not relying entirely on a particular procurement method.

If a portfolio supply procurement approach such as proposed by LEI is approved by the PSC, it would not require any legislative change since Delaware's House Bill 6 provides significant flexibility as to the method of procuring supply for the SOS load. Adjusting the proposed ratios of supply procured through each method over time can ensure that the supply quantities will be adequate given the evolution of wholesale market conditions and RSCI SOS load volume. As such, this would ensure that the proposed portfolio will procure reliable supply for RSCI SOS customers over the long term, while balancing the benefits and costs of striving for the least cost to consumers.

2 Summary of LEI's review of the current SOS procurement approach

In September 2015, LEI submitted a report in Docket 14-0283 reviewing Delmarva's current electricity procurement process as well as alternative procurement methods for the provision of supply to Delmarva's Residential and Small Commercial & Industrial ("RSCI") Standard Offer Service ("SOS") customers (the "September 2015 Report").[6]

The September 2015 Report provided an assessment of the characteristics of Delmarva's current SOS supply procurement approach and qualitatively compared the key characteristics of Delaware's process with mechanisms employed in other jurisdictions. As such, this report was the first step in analyzing the merits, as well as challenges, associated with Delmarva's current SOS supply procurement process, consideration of options, and identification of potential areas of improvement for purposes of stakeholder discussion.

LEI found that since the beginning of FRS procurement for SOS customers in 2005, supplier participation in the FRS supply procurement auctions has been relatively stable.[7] Furthermore, since the current laddered procurement approach for FRS was adopted in 2005, resulting SOS supply costs to Delmarva have reflected the expected dampening and delaying of impact from variations in the wholesale markets. In general, wholesale supply costs have been gradually declining following the post-2008 reduction in economic activity, due to increase in relatively cheap shale gas supply and associated fall in energy prices. However, the 2013-14 period saw a large increase in market prices due to abnormally cold weather.

As part of the September 2015 Report, LEI also reviewed the SOS (or its equivalent)[8] procurement processes from several utilities in the PJM footprint and other deregulated jurisdictions to assess their characteristics. Several utilities currently rely on competitive processes to procure the entire supply for their RSCI SOS customers, similar to Delmarva's procurement process. As such, the products procured through competitive bidding are mostly variations of the FRS product, and the terms for contracted supply range from six months to three years, with some utilities procuring SOS supply for multiple future terms.

LEI also observed that different auction constructs have been adopted in the jurisdictions reviewed. These include: (i) sealed-bid auctions, where the lowest bids fulfilling the supply

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[6] LEI, *Review of Alternative Electricity Procurement Processes for the Provision of Delmarva Power's Standard Offer Service: Task 1 – Electricity Supply Procurement Assessment*, Docket 14-0283, September 23, 2015.

[7] The exception to this trend happened in the 2014-2015 procurement process, which involved only three eligible suppliers submitting offers for load in the RSCI class. Some argue that this was likely due to uncertainty in the PJM capacity market rules in late 2014/early 2015, and the strong participation (7 bidders) in the following 2015-2016 procurement process tends to support that conclusion.

[8] Default Service in Pennsylvania, Basic Service in Massachusetts, Basic Generation Service in New Jersey and Illinois, Standard Service in Ohio & Connecticut.

requirement are selected, and (ii) open auction processes such as reverse auctions and descending-clock auctions, where participants are aware of, and can react to their competitors' bids.

Notable exceptions to procurement of FRS include utilities in Illinois that solicit fixed-quantity, energy-only blocks. These purchases are supplemented with transactions from the spot markets as the load varies on an hourly basis. Another example of a different default load procurement program can be found in Connecticut where one utility is authorized to self-manage 20% of the load using a mix of physical and financial products.[9] While requiring more resources from the utility, this method is expected to yield slightly lower prices for the SOS consumers at the expense of somewhat higher volatility in the retail rates.

Finally, in the September 2015 Report, LEI discussed the key characteristics of the alternative supply procurement methods analyzed in the present report.[10] LEI also introduced the evaluation criteria that are used in this report to discuss the merits and drawbacks of the alternative procurement methods, ultimately resulting in LEI's recommended approach going forward for the procurement of SOS supply for RSCI customers in Delaware.

LEI further discussed and sought feedback on preliminary findings in a workshop on September 15, 2015[11], which was attended by PSC Staff, Delmarva, and other stakeholders. Following the publication of the September 2015 Report, a number of stakeholders provided further feedback on LEI's findings.

Feedback on LEI' report spanned several topics:

- One topic was related to the ability of the SOS provider to effectively manage a portfolio of supply, including generation resources. Comments indicated that marketers and generation owners are better equipped to optimize supply portfolios than the SOS provider;
- Another topic was related to the relationship of SOS supply costs with the underlying prices of wholesale power markets. While some parties were in favor of SOS rates mirroring the wholesale power market conditions (so as to encourage the development of a competitive retail market for customers), other parties stated a willingness to give up price stability in favor of lower prices, and suggested that lower prices can be

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[9] Final Decision. *PURA Docket 12-06-02*, http://www.dpuc.state.ct.us/dockhist.nsf/8e6fc37a54110e3e852576190052b64d/1e131cb621d4643585257c0e004f6203?OpenDocument

[10] In addition to FRS contracts, these methods include purchases from the spot markets, long-term contracts, and building/purchasing own generation.

[11] Meeting Minutes from the workshop are available in Delaware PSC's docket 14-0283

attained through a combination of smaller term contracts and purchases from the spot markets; and

- Separately, some parties emphasized the need to keep the procurement of Renewable Energy Credits ("RECs") separate from the procurement of SOS supply, arguing that long-term contracts with renewable resources would yield lower costs for the renewable attributes.

3 Overview of methodology

In the present analysis, LEI undertook quantitative analysis of alternative SOS procurement methods. The quantitative analysis relied on historical backcast analyses and forward-looking modeling. LEI also considered several qualitative factors, in order to evaluate different procurement strategies. This report culminates with recommendations for potential alternative supply procurement strategies for Delmarva's RSCI SOS customers (see Section 6).

The four procurement options introduced in LEI's September 2015 Report are:

1. Purchases from the spot markets;
2. Full Requirement Service;
3. Long-term contracts; and
4. Purchasing/building own generating resources.

LEI first evaluated quantitatively and qualitatively each procurement method independently, and then assessed alternative procurement portfolios that combine several procurement options. LEI tested six sample portfolios, combining specific percentages of supply procured from one of the methods listed previously.

For each individual procurement option, LEI assessed the following quantitative and qualitative factors:

Supply cost
LEI assessed the supply cost of each procurement method as the average cost of supply, in nominal dollars per MWh, expected over a reference period. The historical reference period encompasses the 2007-08 to 2014-15 delivery periods, while the forward-looking reference period encompasses the 2016-17 to 2024-25 delivery periods. The cost of supply includes all electricity supply components currently procured through FRS, such as energy, capacity, ancillary services, and Independent System Operator ("ISO") fees, but excludes Renewable Energy Credits ("REC").
Supply cost variability
LEI assessed the variability of RSCI SOS supply costs for each procurement option as the standard deviation of year-over-year changes in supply costs, expressed in dollars per MWh.
Administrative cost
The administrative cost for each procurement option includes the additional implementation cost for a procurement method, such as the cost of a web-based Full Requirement Service ("FRS") auction platform or the cost of an agent conducting transactions in the PJM spot markets on behalf of the SOS provider.

Other considerations

This qualitative discussion includes such topics as ease of implementation, consistency with Delaware policies & goals, consistency with wholesale markets, and regulatory/legal considerations.

As will be further discussed in the following sections, the cost of procuring SOS supply for alternative supply procurement methods is generally driven by the underlying cost of electricity in the spot markets. The most obvious example is procurement of supply directly from the spot markets. FRS supply is also based on expectations of market prices (plus appropriate risk margins and profit allowance). Long-term contract procurement, when conducted on a competitive basis with a sufficient number of participants, is also expected to yield contract prices consistent with market expectations for future spot market prices over the contract term. The exception is procuring supply through a generation resource(s) owned by the SOS provider, where supply costs are driven by the fixed costs, fuel costs, and other variable operating costs of the resource. Consequently, for those procurement methods where supply costs are driven by the wholesale market prices, LEI assessed the electricity cost and variability of each procurement method first on a historical basis (using actual historical prices from the PJM markets), and then on a forward-looking basis (using a Base Case market price outlook and various sensitivity scenarios, which are discussed in further detail below).

For the historical analysis, LEI used actual realized PJM market prices to estimate the SOS supply costs assuming that alternative supply procurement methods had been used by the SOS provider. LEI included data from 2007-2008 through 2014-2015 delivery periods to capture as much information as possible on changing market conditions, occurrence of one-off events, and the impacts on costs and variability thereof. Even though we used realized market prices, the procurement scenarios remain hypothetical (except for the procurement of three-year FRS contracts),[12] as they represent an attempt to determine resulting supply costs had the SOS provider undertaken different procurement methodologies.

For the forward-looking evaluation of each procurement option, LEI elected to illustrate the different characteristics and implications for SOS supply costs using alternative procurement methods by testing multiple scenarios, each representing separate trajectories for market conditions. When creating a Base Case forward-looking price scenario, LEI relied on fundamental power market drivers to create weather-normalized market outlooks using its proprietary POOLMod energy market model,[13] as well as its proprietary Excel-based Reliability

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[12] Actual historical data was used for the cost of FRS procurement.

[13] See appendix A for a description of LEI's POOLMod energy market model

Pricing Model ("RPM") Base Reconfiguration Auction ("BRA") model.[14] LEI further created synthetic market outlooks to test "what if" scenarios to test the performance of alternative procurement methods or portfolios under specific market outcomes. The synthetic outlooks are important not so much for showing the absolute level of supply costs under each scenario, but rather for demonstrating how the expected cost and variability of supply costs with each procurement method or portfolio would change relative to one another.

Overall, LEI used five distinct scenarios for the analysis of RSCI SOS supply procurement methods:

Historical scenario
Historical prices, encompassing the 2007-08 to 2014-15 delivery periods.
Forward looking Base Case scenario
Base Case weather-normalized outlook for energy and capacity over ten years (2016-2025), based on simulation modeling, representing LEI's view on the most likely outcome given current market knowledge.[15]
Forward looking Low Price scenario
Low Price weather-normalized outlook, representing a synthetic hypothetical scenario over ten years (2016-2025), where the trajectory for wholesale market prices is lower than the Base Case outlook.
Forward looking Price Shock scenario
Price Shock outlook representing a hypothetical scenario over a ten year period (2016-2025), featuring one sharp increase in electricity costs, followed several years later by a sharp decline in electricity prices.
Forward looking High Migration scenario
High SOS customers migration rate scenario, representing a hypothetical scenario where RSCI SOS load would decline over time with respect to the 2014 Integrated Resource Plan ("IRP") forecast.

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[14] LEI updated the forecast for PJM market prices in February 2016 as part of its Continuous Modeling Initiative ("CMI"). The complete CMI document for PJM, as well as for other US and Canadian jurisdictions, are available at www.londoneconomicspress.com

[15] As of February 2016

LEI's use of weather normalized forecasts[16] results in reduced variability of energy prices over the forecast horizon, as compared to real-life market prices. LEI accounts for this artificially low variability in the energy prices when assessing the variability of supply costs from different procurement methods, as discussed later in Section 4.1.2.

In addition to historical prices and the Base Case scenario, LEI relied on additional scenarios deviating from expected market conditions.

The Low Price scenario is designed to illustrate the effect of wholesale market prices deviating from the expected Base Case scenario. This in turn will reflect the potential of procurement methods or portfolios to accurately reflect actual market conditions if market outcomes deviate from expected trends.

The Price Shock scenario is designed to illustrate the effect of large wholesale market price variations from the expected Base Case trend. This in turn will reflect how large variations in market prices are reflected in supply costs under the various procurement methods, in addition to expected market costs.

Finally, the High Migration scenario is designed to illustrate the effect of a significant change in the amount of RSCI SOS load levels over time. This, in turn, will reflect the exposure of the procurement methods or portfolios to demand volume uncertainty, and the value of risk associated with this uncertainty.

3.1 Historical energy and capacity prices

For the historical scenario, LEI relied on actual hourly Day-Ahead ("DA")[17] energy market prices for the DPL zone, encompassing the 12 month delivery periods (from June to May) ranging from 2007-08 to 2014-15. For the capacity prices, LEI relied on actual realized capacity prices for the relevant capacity zone[18] from past BRA and reconfiguration auctions. Figure 1 illustrates the historical energy and capacity wholesale market prices for Delmarva's service area.

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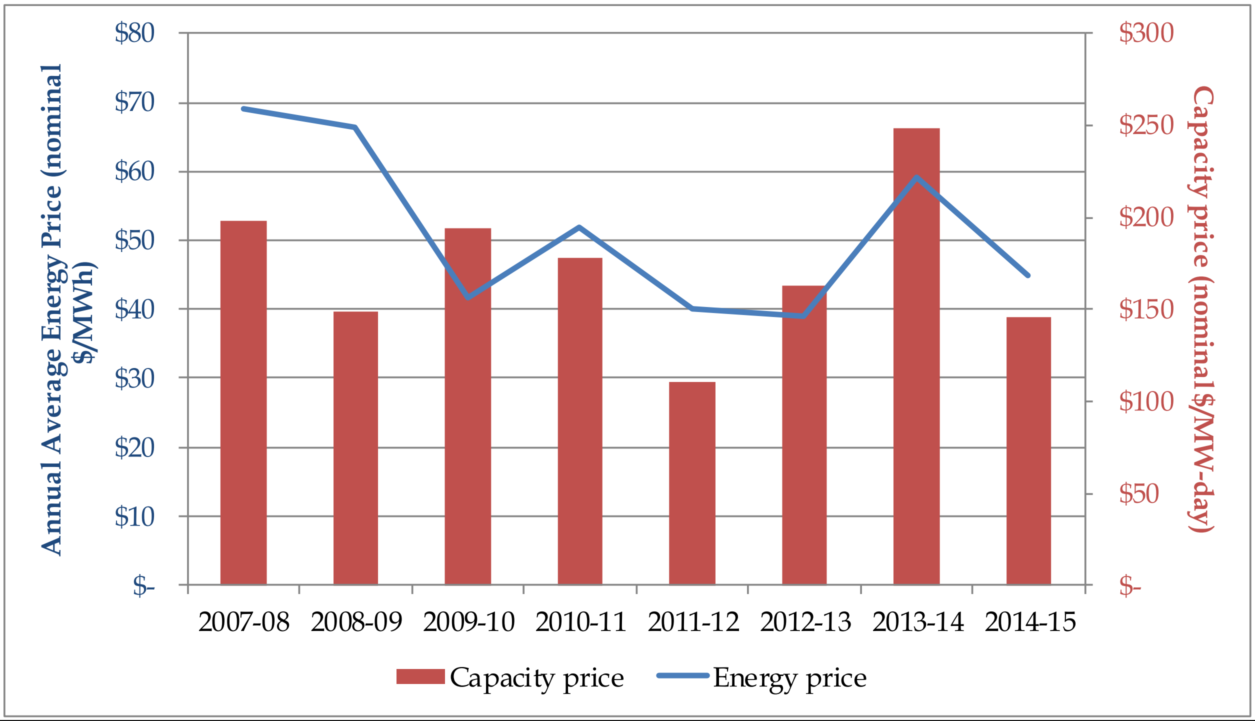
[16] A weather normalized forecast is based on weather patterns designed to reflect average historical weather conditions. As such, load, fuel prices, and other market drivers influenced by weather will not exhibit as strong year-over-year variations as in real life.

[17] LEI relied on DA prices as most load is bid in the DA market. Furthermore, the markets are designed for the DA and real-time prices to converge so both markets will exhibit on average similar price levels. The real-time and DA markets are discussed in more details in Appendix B (Section 8.1.1).

[18] Depending on zonal price separation in the BRA, the capacity price applicable to DPL SOS customers has included zones RTO, MAAC or DPL in past auctions.

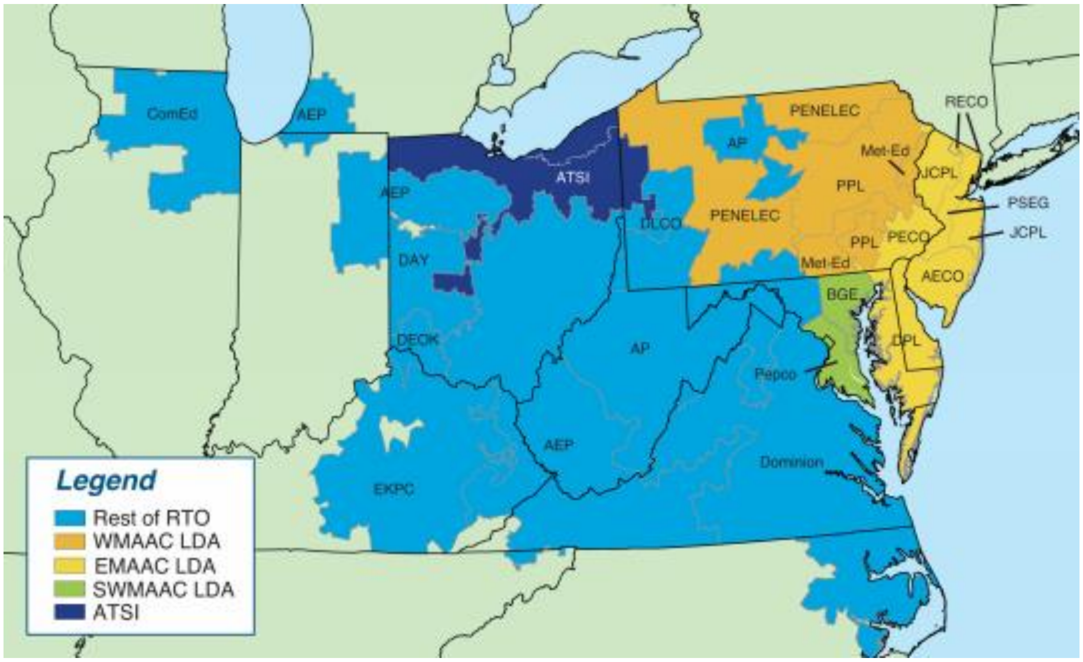
Figure 1. Historical energy and capacity spot market prices for Delmarva service territory



It is noteworthy that energy prices were noticeably higher for the 2007-08 and 2008-09 periods when compared to subsequent periods. The decline in prices is attributable to changes in fundamental market drivers such as the 2009 recession and low natural gas prices caused by increased production from shale regions. Energy prices in 2013-14 saw a sharp rise due to exceptional "winter vortex" weather conditions from December through March, leading to very high natural gas prices during this winter period.

Capacity prices on the other hand are generally independent from energy load levels and weather conditions, but are primarily tied to load growth and supply changes. Capacity prices are also somewhat linked to long-term trends in fuel prices (since these affect generators' revenue requirement from the capacity market). Due to transmission constraints, capacity prices in the DPL zone (or its parent EMAAC or MAAC zones) have separated for some years from prices for the rest of the PJM Regional Transmission Organization. As a result of the transmission constraints, more expensive resources are susceptible to set the auction clearing price, similar to what has been observed in the 2014-2015 period. Figure 2 illustrates PJM's capacity regions.

Figure 2. PJM Capacity Zones



Source: PJM

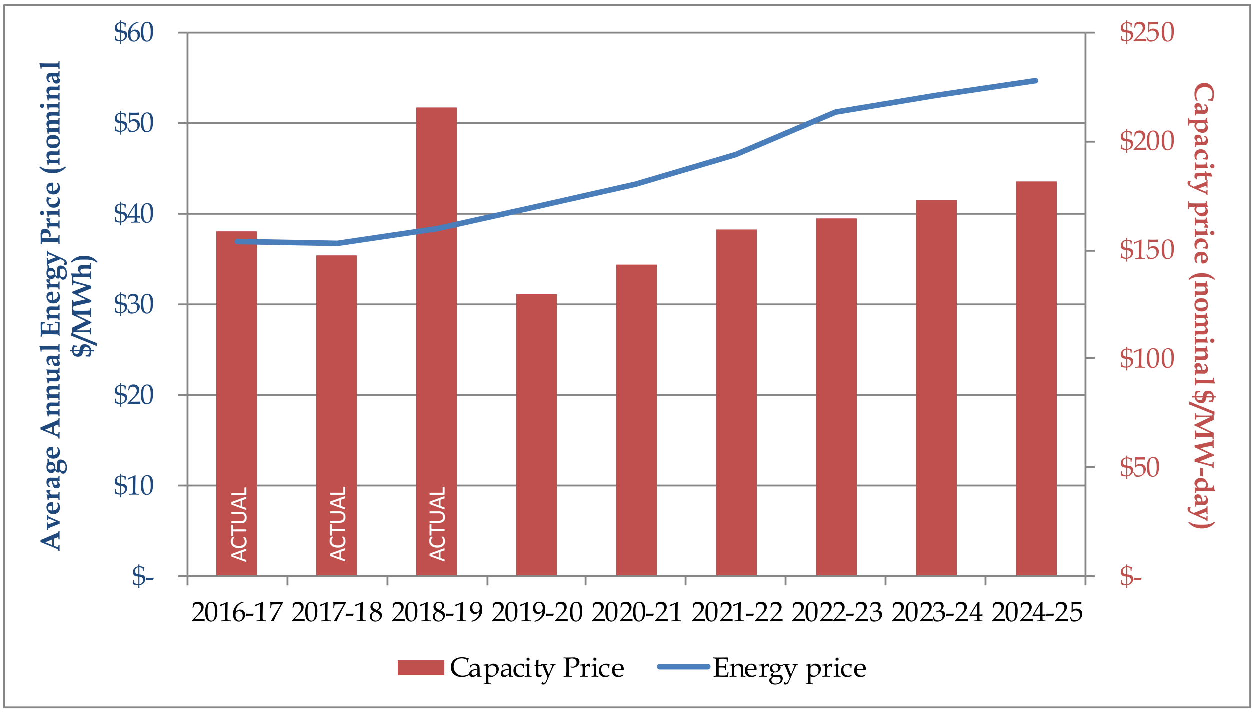
3.2 Base Case ten year weather-normalized outlook for energy and capacity prices

LEI's ten year Base Case outlook for energy and capacity is based on simulation modeling using LEI's proprietary POOLMod energy market model[19] as well as an Excel-based RPM BRA model, which is integrated with the POOLMod simulations. Inputs to these models represent LEI's view on the most likely outcome given current market knowledge.[20] Model inputs include demand forecasts, fuel prices, emission allowance costs, operating parameters for supply resources, import/export transactions, and transmission interface transfer limits. Figure 3 illustrates the Base Case scenario's energy and capacity wholesale market price outlook for Delmarva's service area used in this report.

[19] See appendix A for a description of LEI's POOLMod energy market model

[20] Based on LEI's Q4 2015 CMI forecast, which was updated with PJM's 2016 load forecast report

Figure 3. Base Case energy and capacity spot markets price outlook



Source: LEI February 2016 CMI forecast

Using a Base Case composite of expected assumptions, LEI's analysis of the PJM electricity market forecasts that average annual energy prices for the DPL zone are expected to rise from around $37/MWh for the 2016-17 period, to about $55/MWh in 2024-25. Over the 10 year forecast horizon, energy prices are expected to grow on average 4.6% per year.

DPL energy prices are influenced by several factors, namely: natural gas prices, coal retirements, market penetration of gas-fired fuel plants, transmission constraints, and the implementation of the Clean Power Plan ("CPP"). From 2016 to 2017, energy prices are forecast to decrease as a result of the decline in underlying projections of gas prices and anticipated entry of new gas-fired plants (which have already committed to the PJM market in prior BRAs). Prices will then increase between 2017-2022 following the trend in fuel prices, mainly natural gas prices. Around 2022, LEI expects that there will be upward movement in electricity prices across PJM with the implementation of the CPP,[21] which requires all fossil fuel-fired plants to reduce their CO_2 emissions and/or to purchase a CO_2 emissions allowance in order to achieve

[21] Even though the Supreme Court granted a stay shortly after LEI prepared this forecast, we believe that it is still likely that some form of carbon pricing will be implemented in the long run across the US, although there is uncertainty about the implementation of CPP Final Rule. That said, these results are still valid as an indication of future energy prices with carbon pricing.

the nationwide goal of 32% reduction in CO_2 emissions by 2030. Energy prices in PJM East (which includes the DPL zone) is not expected to increase as substantially as in PJM West due to the difference in the fuel mix.

In terms of capacity prices, LEI assumed that there would not be price separation between the DPL or EMAAC zones and the MAAC zone. This is due in part to new generation resources, mostly natural gas-fired CCGTs, which are expected to come online and reduce the likelihood of capacity price separation. As such, LEI based the capacity price forecast in the Base Case on the MAAC zone.

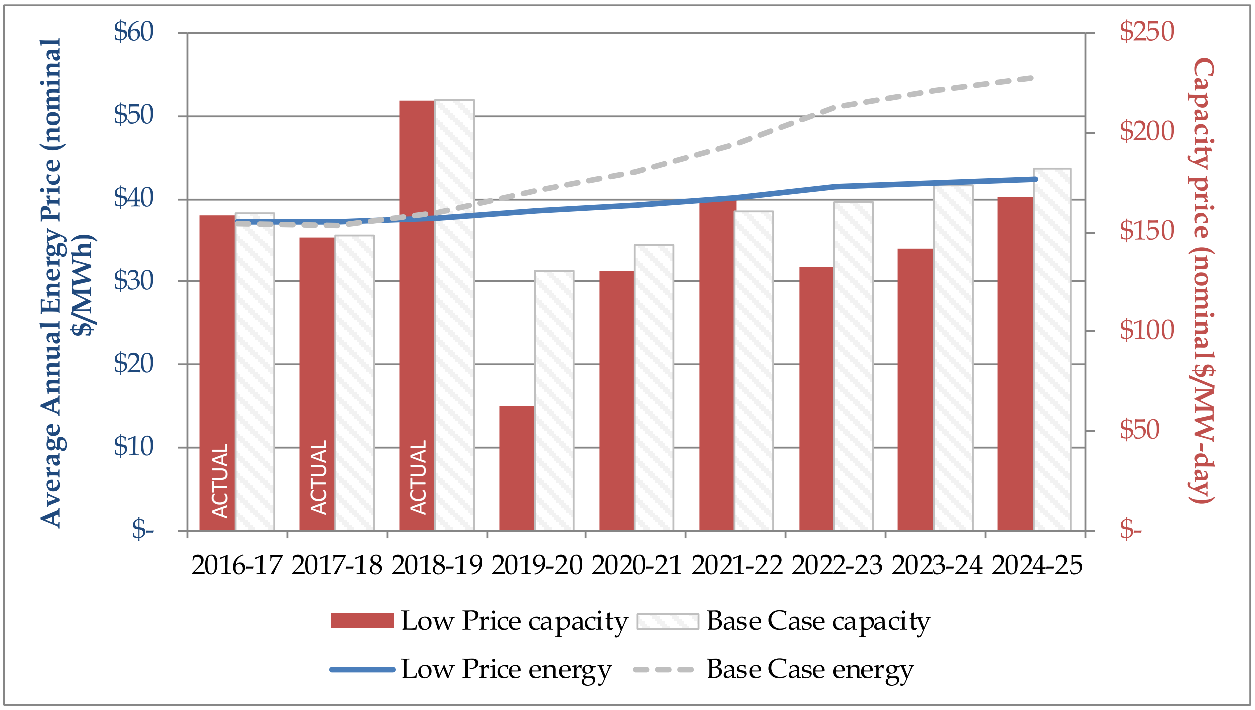
Capacity prices for delivery year 2019/2020 are forecast to drop due to the updated lower demand growth, which impacts the demand curve used to determine the capacity price. However, capacity prices will increase starting in the 2020/2021 delivery year. The key drivers for the projected increase in capacity prices include PJM's procurement of the Capacity Performance product starting in the 2018/2019 delivery year. This, in turn, increases the offer/bid of plants to reflect additional investments required to ensure continued operations during emergency conditions, coal retirements in the mid-term due to old age and inefficiencies, and implementation of the proposed CPP, which increases the fixed costs of carbon emitting plants. Furthermore, unlike in the past, Demand Response ("DR") resources in the coming auctions are not expected to increase as a consequence of the cap imposed by PJM in 2014. There is also a cap on the participation of external resources in the capacity market. As such, a substantial increase in imported capacity resources is not expected over the forecasted period.

3.3 Low Price ten year outlook for energy and capacity prices

LEI's synthetic ten year Low Price outlook (2016-2025) for energy and capacity illustrates a case where growth in energy and capacity prices is much lower than in the Base Case. This outcome could be attributable to a number of factors, such as low growth in fuel prices or load, entry of multiple new generation resources, or delay in the implementation of the CPP, with respect to the Base Case scenario. The actual level of prices in the Low Price scenario is not as important as the impact these prices have on the cost of supply from alternative procurement methods relative to one another, when compared to supply costs in the Base Case scenario.

The Low Price scenario is useful for evaluating the consequences of wholesale market prices diverging from the expected Base Case scenario. For instance, if a long term contract is entered into with the expectation of Base Case energy and capacity prices, lower prices than expected could result in the contracted supply costs diverging from actual market conditions. Figure 4 illustrates the Low Price scenario energy and capacity wholesale market price outlook for Delmarva's service area.

Figure 4. Low Price energy and capacity spot markets price outlook



Source: LEI (synthetic outlook)

In the Low Price scenario, prices for energy are around $37/MWh for the 2016-17 period, increasing to about $42/MWh in 2024-25. Over the 10 year forecast horizon, energy prices grow on average 1.5% per year. Energy prices in the Low Price scenario are on average 12% lower relative to the Base Case scenario. Capacity prices in the synthetic Low Price scenario decline in the 2019-20 period from the 2018-19 levels, but rally in later years to compensate for the lower revenues from the energy markets. Capacity prices in the Low Price scenario are on average 10% lower than in the Base Case scenario.

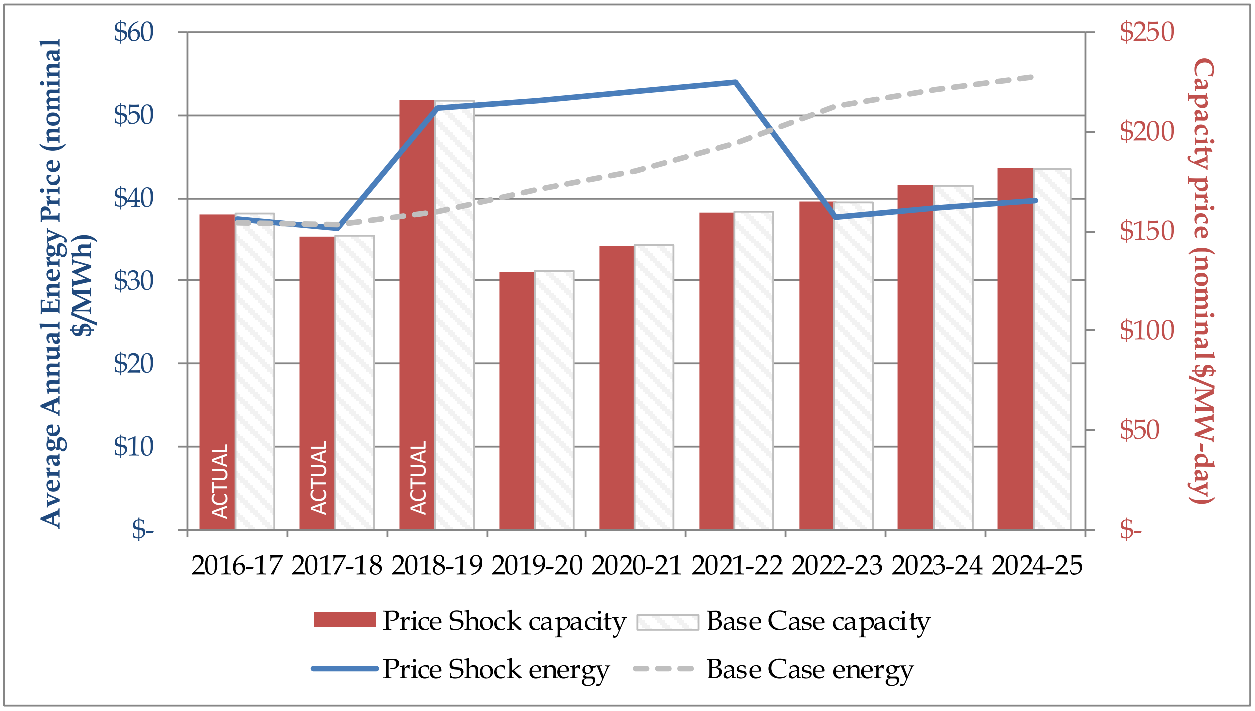
3.4 Price Shock ten year outlook for energy and capacity prices

LEI's ten year Price Shock scenario (2016-2025) for energy and capacity is not based on simulation modeling, but rather is a "synthetic" hypothetical outlook designed to exhibit large variations in year-over-year prices for electricity supply. Potential events that could lead to such a scenario include:

- extreme weather;
- higher natural gas prices resulting from a significant increase in exports of Liquefied Natural Gas out of the country;
- massive retirements of coal generation for economic or environmental reasons; or
- regulatory changes in the PJM markets.

The Price Shock scenario is useful for evaluating the sensitivity, or year-over-year variability, in supply costs under various procurement alternatives or portfolios if market price outcomes diverge significantly from expected levels. The large difference in electricity prices in the spot market will highlight the high variability of spot markets with respect to some other procurement methods such as long term contracts or three year, laddered FRS contracts. Figure 5 illustrates the Price Shock scenario's energy and capacity wholesale market price outlook for Delmarva's service area.

Figure 5. Price Shock energy and capacity spot markets price outlook



Source: LEI (synthetic outlook)

In the Price Shock scenario, energy prices are similar to the Base Case for the first two years of the forecast. The energy prices then exhibit a large 40% increase in the 2018-19 period, and subsequently increases 2% per year until the 2022-23 period, after which time there is a sharp 30% decline in prices. Energy prices then increase 2% per year until the end of the forecast. In this synthetic hypothetical scenario, LEI assumed that the capacity prices would remain the same as in the Base Case scenario.

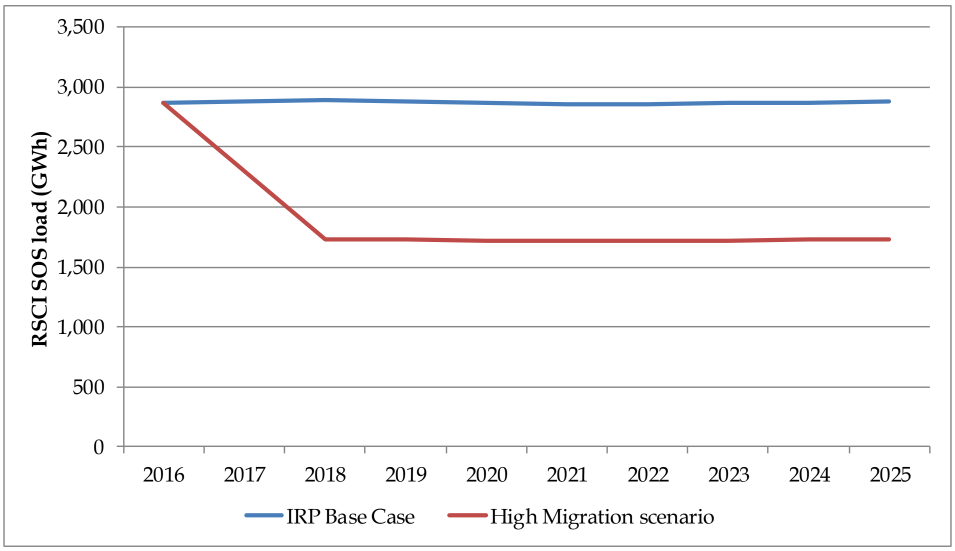
3.5 High Migration rate for RSCI SOS customers

LEI's last scenario is not a variation on the spot market price outlook, but rather a hypothetical scenario designed to showcase the effect of a significant decline in RSCI SOS customer load, for instance through a larger than expected migration rate towards competitive retail suppliers. While the variation in load will not affect the cost of supply purchases through the spot markets, it can affect the realized cost from other procurement methods such as FRS, as suppliers may increase the risk premium embedded in their offer following large and unpredictable variations in load volume to account for the added uncertainty. Similarly, the variation in load can affect supply procurement through long-term contracts (assuming a fixed quantity contract), as varying the amount of load will modify the overall cost per MWh of SOS load served.

Delmarva's 2014 IRP long-term RSCI load forecast is based on a ratio of 89% of RSCI load in its service territory being served through SOS. LEI's hypothetical High Migration rate scenario assumes a decline of 40% in load over two years with respect to the 2014 IRP RSCI SOS outlook, which would correspond to approximately 53% of RSCI load in Delmarva's service territory being served through SOS.[22]

Figure 6 illustrates the comparison between the load forecast in Delmarva's 2014 IRP, used for the Base Case and all scenarios with the exception of the High Migration scenario, and the adjusted load level in the High Migration scenario.

Figure 6. RSCI SOS load forecast for Base Case and High Migration scenario



Sources: Delmarva 2014 IRP, LEI (synthetic outlook)

[22] Although hypothetical, the approximately 50%migration rate is on the high end of average migration rates for residential and commercial customers in states which offer retail choice.

4 Characteristics of alternative procurement methods

Among the four procurement methods introduced in Section 3, each has different characteristics in terms of overall cost, variability, administrative cost, and ease of implementation. This section details the characteristics of each supply procurement method using quantitative metrics (such as average cost of supply and expected variability of supply costs). LEI also discusses advantages and drawbacks of each method on a qualitative basis. In addition to the individual supply procurement method, LEI also discusses the possibility of combining various methods into a procurement "portfolio".

In general, direct purchases from the spot market not only ensure that SOS costs reflect the underlying cost of electricity, but also amplify potential for large variability in year-over-year supply costs. This latter characteristic may not be viewed favorably by the Delaware PSC and the SOS provider. Long-term contracts, on the other hand, offer price stability through fixed supply costs but run the risk of diverging (in either direction) from realized spot market prices. Laddered FRS supply contracts are based on wholesale market expectations and can dampen annual fluctuations in prices, but the lower risk comes at the expense of higher costs through premiums embedded in suppliers' offers. Finally, an SOS provider can own/build its own resources, which may end up being less expensive than buying power from the markets, but will then need to oversee the plant's operations and mitigate the risks involved in the operation of a power plant.

It is possible to diversify the cost and risk profile associated with the various supply procurement methods by combining these methods into a procurement portfolio. In doing so, the SOS provider would procure supply for varying percentages of its load using different procurement methods. An example of such a portfolio would have FRS suppliers serving a percentage of the SOS load, with the remaining load served through a fixed-quantity long-term contract, supplemented through spot market purchases. As discussed in more detail in LEI's September 2015 Report, Connecticut and Illinois are examples of states where utilities combine various methods to procure supply for their Standard Service (Connecticut) and Basic Generation Service (Illinois).

4.1 Spot market purchases

4.1.1 Supply cost

Calculating the cost of electricity supply purchased from the spot markets requires inclusion of the cost of each of the components of supply, such as energy, capacity, ancillary services, and other ISO fees.[23]

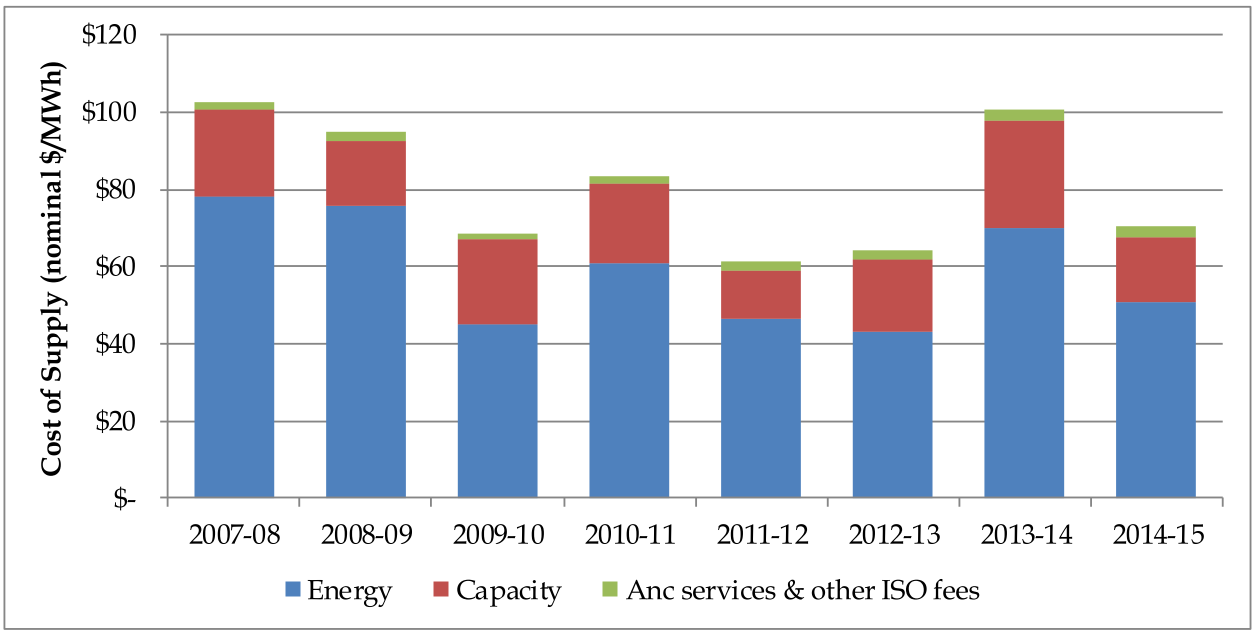
[23] LEI's methodology for calculating the cost of electricity supply when purchased from the spot markets is discussed in Appendix B (Section 8.1.1).

In order to calculate energy supply costs, LEI considered both the hourly shape for market prices and the hourly RSCI SOS load profile. Since energy prices tend to be highest when load is highest, the cost of energy supply is the weighted average of the hourly load and hourly market clearing price, and will be higher than a simple, unweighted average of hourly prices.

When calculating the costs of the capacity component, LEI converted the capacity market prices from dollars per MW-day into dollars per MWh. To do so, LEI estimated a load factor for RSCI SOS customers, which is necessary to relate the capacity requirement with the actual energy consumption, in order for capacity costs to be comparable to energy costs.

For calculating the cost of ancillary services and other ISO fees, LEI relied on historical data to estimate a ratio between the cost of ancillary services and the price of energy in the PJM market. Using this data, LEI postulated that the cost of ancillary services and other ISO fees would remain a steady percentage of energy prices in the future, and as such considered, for each forward-looking scenario, that annual ancillary service costs would represent approximately 5.8% of the annual energy price.

Figure 7. Hypothetical historical cost of RSCI SOS supply had it been purchased from the spot markets (nominal $/MWh)

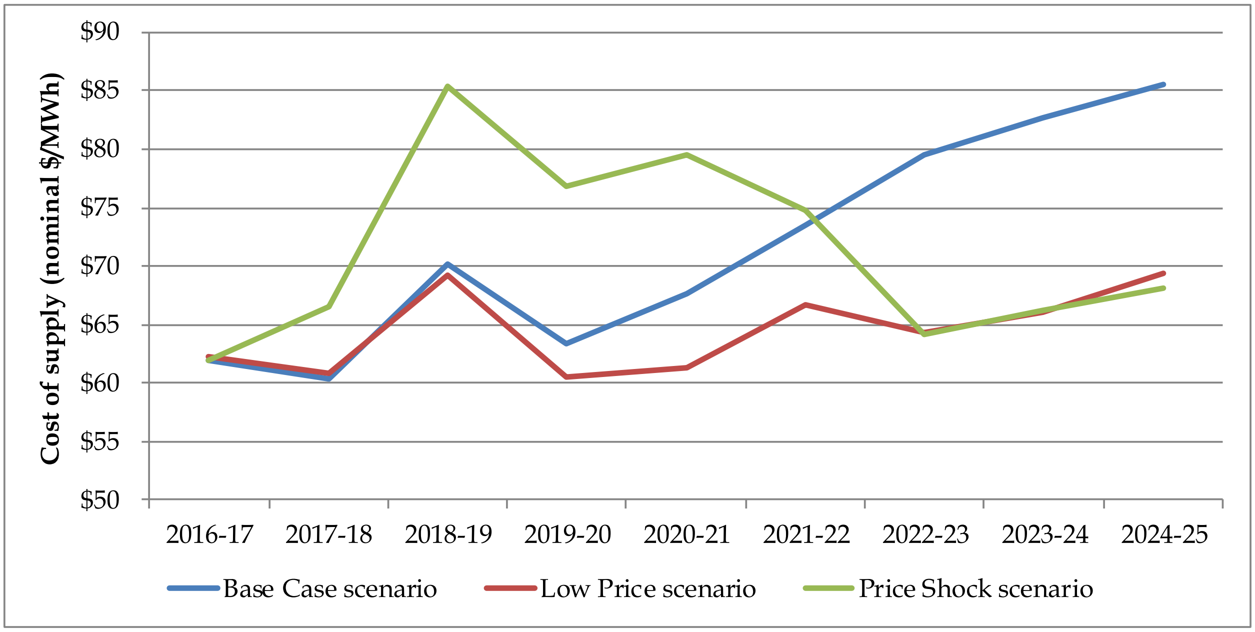


Component	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	Average
Energy	$ 78.0	$ 75.7	$ 44.8	$ 61.0	$ 46.5	$ 43.1	$ 69.8	$ 50.8	$ 58.7
Capacity	$ 22.5	$ 16.9	$ 22.0	$ 20.3	$ 12.5	$ 18.5	$ 28.2	$ 16.5	$ 19.7
Anc services & other ISO fees	$ 2.3	$ 2.1	$ 1.8	$ 2.4	$ 2.5	$ 2.5	$ 2.8	$ 3.3	$ 2.4
Total	**$ 102.8**	**$ 94.7**	**$ 68.6**	**$ 83.6**	**$ 61.5**	**$ 64.1**	**$ 100.8**	**$ 70.6**	**$ 80.8**

Using historical prices for the 2007-08 to 2014-15 delivery periods as discussed earlier in Section 3.1 and the methodology described in appendix B, LEI calculated a hypothetical cost had the

RSCI SOS supply been purchased directly from the spot markets. The resulting supply costs are illustrated in Figure 7.

Figure 8. Hypothetical forward cost of RSCI SOS supply if purchased from the spot markets for various scenarios (nominal $/MWh average over 2016-17 to 2024-25 horizon)



Average spot market supply cost over 2016-2025 horizon (nominal $/MWh)			
Electricity supply component	Scenario		
	Base Case	Low Price	Price Shock
Energy	$ 50.4	$ 44.7	$ 50.3
Capacity	$ 18.6	$ 17.6	$ 18.6
Ancillary services & other ISO fees	$ 2.6	$ 2.3	$ 2.6
Total	**$ 71.6**	**$ 64.5**	**$ 71.5**

Similarly, using forward prices for each of the pricing scenarios (as described earlier in Section 3.2 to Section 3.4),[24] LEI calculated a forward cost of supply, assuming it was purchased from the spot markets. As LEI's outlook represents a weather-normalized forecast, the important features of the following figure are the trends in prices and 10 year average. Figure 8 illustrates the anticipated cost for each component of supply, and the total cost, assuming purchases from the spot markets under each pricing scenario.

[24] As the costs of purchasing supply from the spot markets are expressed in dollars per MWh, and the market prices won't vary according to the amount of load purchased by the SOS provider, the actual migration rate will not affect total supply costs. As such, the High Migration scenario is not illustrated here.

The hypothetical forward total cost of RSCI purchased from the spot markets for each scenario is consistent with the pricing scenarios defined previously, with the average supply cost in the Low Price scenario approximately $7/MWh less expensive than in the Base Case scenario. The Price Shock scenario exhibits an average supply cost over the forecast period similar to the Base Case, however the annual supply costs differ between the two scenarios.

4.1.2 Supply cost variability

As shown earlier in the chart of historical prices (Figure 1 on page 18), wholesale market electricity prices (energy and capacity) can exhibit large year-over-year variations. These large variations can be attributed to several factors, such as:

- changes in fundamental market drivers (such as increased/decreased economic activity, changes in supply resources, changes in the natural gas markets, or other more radical changes such as economic recessions or the appearance of natural gas extracted from shale);
- weather related factors (weather patterns affect load levels, fuel prices, and plant availability), which affect energy prices;
- timing and magnitude of outages (for both transmission and generation), which also affect energy prices; and
- regulatory changes (for instance, changes in energy offer cap, or the introduction of the Capacity Performance product in the RPM).

As a result, it is important to consider the variability of spot market purchases when assessing this method of supply procurement. LEI calculated the historical variability of supply costs if purchased from the spot markets as the standard deviation of the year-over-year changes in cost. For forward-looking scenarios, however, LEI used a hybrid approach and combined the variability intrinsic to the weather-normalized outlooks, which represents changes in fundamental market drivers, with the weather-driven variability of spot market costs derived from historical data. [25] Figure 9 illustrates the resulting variability of cost for supply procured through the spot markets for all pricing scenarios.

Historical variability is the highest among all pricing scenarios, as historical costs have been higher than the projected outlook average costs. Furthermore, historical costs combine the effects of weather and major fundamental changes in the market (such as reduced demand as a consequence of the recession of 2008-09 and the appearance of low priced natural gas from shale regions). As a result, since the forward outlooks do not foresee all such impacts, their variability is lower than the historical value. As can be expected, the variability of the Price Shock scenario is higher than the Base Case and Low Price scenarios, since there is an implicit

[25] Appendix B (Section 8.1.2) details LEI's methodology for calculating supply cost variability when purchased from the spot markets.

assumption of large year-over-year variability (although not as large as observed in the last 10 years on average).

Figure 9. Variability of spot market purchases for all pricing scenarios ($/MWh)

Scenario	Variability ($/MWh)
Historical	$ 24.4
Base Case	$ 15.4
Low Price	$ 13.9
Price Shock	$ 17.1

4.1.3 Administrative costs

Spot market purchases mean that the Load Serving Entity ("LSE"), or a third party working on its behalf, is registered with and willing to participate in the PJM wholesale markets.[26]

LSEs are allowed to place hourly fixed demand or price sensitive bids in the energy Day-Ahead ("DA") markets. DA fixed demand bids mean that the LSE is willing the purchase a certain amount of energy at the DA price, whatever that price may be. Price sensitive bids, on the other hand, represent a price ceiling for energy above which the LSE is not willing to purchase energy from the DA market.

In the Real-Time ("RT") market, however, there are no demand bids and all load is treated as price insensitive. If no bids cleared in the DA market, or if RT load differs from the DA cleared demand, the difference between RT load and cleared DA bids is settled at the RT price. Hourly RT prices are typically more volatile than DA prices since unplanned real time events can dramatically alter the supply/demand relationship and necessitate the dispatch of expensive, fast response resources.

In its simplest form, an LSE could elect not to submit any bid and settle all load at the RT price. Alternatively, the LSE can submit fixed demand DA bids equivalent to its load forecast for the delivery day, in order to settle most load at the DA price. Finally, hybrid strategies can have the LSE bid only a portion of its load in the DA market, possibly using price sensitive bids to arbitrage the DA and RT markets. Furthermore, spot market volatilities can be mitigated by hedging a part of the purchased portfolio using commodity derivatives and financial instruments. However, these trading and hedging strategies would require analytical resources and additional costs for development of a risk management plan and trading capabilities (with expert analysts/traders). We understand that Delmarva does not currently have such resources.

[26] PJM's Member List shows that Delmarva is registered as a market participant in the Electric Distributor sector. <http://www.pjm.com/about-pjm/member-services/member-list.aspx>

Realistically, in order to participate in the wholesale energy markets, LSEs therefore need some resources with scheduling capabilities. A spot market procurement strategy however does not require in-depth analytical resources. It is further possible to subcontract the scheduling functions to a third party who would be responsible for entering bids in the PJM markets and generally perform the duties of a market participant. Approximate prices for these services are in the range of $1/MWh to $2/MWh.[27]

For capacity purchases from the spot market, no action is required from the LSE as it is allocated a share of overall capacity market costs according to the ratio of its Peak Load Contribution ("PLC") with respect to the overall PJM peak load value.

Ancillary services and ISO fees similarly do not require direct action by the LSE, as the costs in dollars per MWh are allocated by PJM as a function of its ancillary services activities in the wholesale markets.

Other administrative requirements include the accounting and settlement with PJM for electricity purchases. However, the mid office and back office requirements when purchasing electricity from the spot markets should not place significant additional burden on the SOS provider, as management of the current FRS contracts already requires credit policies as well as accounting and settlement of electricity supply provided by the suppliers.

4.2 Full Requirements Service

4.2.1 Product characteristics

FRS is the procurement method currently used by the SOS provider in Delaware to procure electricity supply through annual solicitations (each annual solicitation features two auctions). FRS in Delaware is a fixed price bundled product which includes energy, capacity, ancillary services and other ISO fees.[28] Since FRS obligation quantities represent a specific percentage of customer load, the supplier not only bears the risk associated with electricity prices (i.e., market price risk) but also load variations (i.e., volume risk). As such, the cost of FRS supply to SOS customers not only includes the cost for electricity supply as forecast at the time the auctions are held, but also includes a premium to cover the supplier's risks.

Currently, Delmarva annually procures an amount of FRS supply equivalent to a third of its RSCI SOS load, with contracts having a term of three years. The length of the contract does have bearing on the risk factors considered by the supplier when preparing a fixed price FRS offer. On one hand, longer contracts could translate into greater load and price risk for the supplier.

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[27] LEI has worked with clients seeking scheduling services, where the combination of the flat fee and "per MWh" fee for such services resulted in approximate costs in the range of $1/MWh to $2/MWh.

[28] Characteristics of the FRS product are discussed in depth in LEI's September 2015 report

On the other hand, however, longer contracts mean that the offer would not be as dependent on weather because the average weather conditions over a longer period are less volatile than conditions for a single year. These contracts can also provide security to suppliers through a known fixed price revenue.

Based on LEI's analysis of the results from past FRS auctions (from 2007-08 to 2015-16), the risk premium embedded in supplier offers has averaged approximately $10/MWh.[29,30] As discussed above, contracts shorter than three years could result in a lower risk to the supplier from changes in fundamental market drivers, but higher risk on weather conditions. As a result, the overall risk premium embedded in a supplier's offer would depend on the supplier's assessment of each risk factor.

4.2.2 Supply cost

For historical periods, the costs of FRS supply can be calculated from past auction results. Furthermore, since supply procured in a procurement event represents one third of Delmarva's RSCI SOS load, the average cost of supply for a specific delivery period corresponds to the average of results from the previous three procurement events.

As discussed previously, FRS contracts can be purchased for any length of time. As such, in addition to the actual historical cost of SOS supply procured through three year FRS contracts, LEI calculated a hypothetical historical cost of SOS supply had it been purchased with one or two year contracts. LEI adapted the laddering to correspond to the contract length, e.g. 100% of supply is procured each year under one year contracts (no laddering), or 50% of supply is procured each year for two year contracts (50% laddering). The resulting hypothetical costs of FRS supply are shown in Figure 10, together with the actual costs incurred with three year contracts.[31] LEI assumed an identical $10/MWh risk premium embedded in suppliers' offers for one, two, or three year FRS contracts for the reasons discussed in Section 4.2.1. LEI acknowledges, however, that suppliers could have modified the risk premium embedded in their offer had the contract length been different. The hypothetical historical cost of supply, assuming purchases from the spot markets, is included for comparative purposes.

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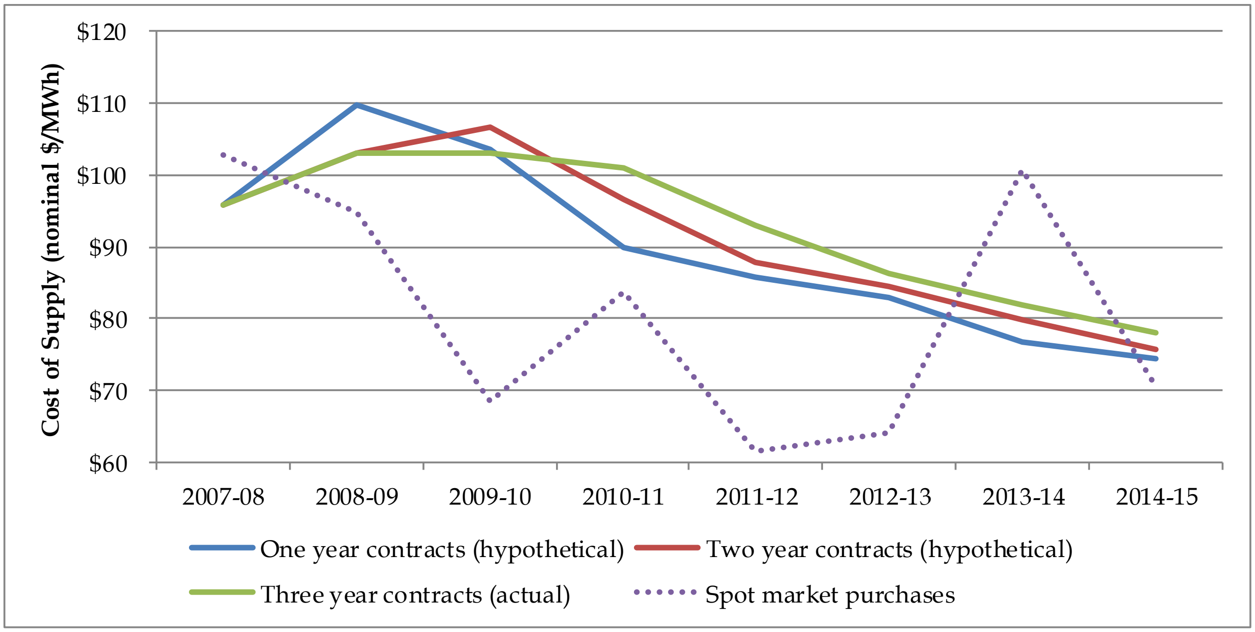
29 Appendix B (Section 8.2.1) details LEI's methodology for calculating the average FRS risk premium embedded in supplier's offers.

30 Fees for the third party supplier of the web-based auction platform are confidential, but are paid by the winning bidder(s). Therefore, the historical $10/MWh risk premium calculated by LEI is assumed to also include the auction fee.

31 Appendix B (Section 8.2.2) details LEI's methodology for calculating the average FRS supply cost.

Figure 10. Hypothetical and actual historical cost of RSCI SOS supply when purchased through FRS contracts (nominal $/MWh)



Contract Length	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	Average
One year contracts (hypothetical)	$ 95.8	$ 109.9	$ 103.5	$ 90.0	$ 85.9	$ 83.0	$ 76.8	$ 74.5	$ 89.9
Two year contracts (hypothetical)	$ 95.8	$ 103.2	$ 106.7	$ 96.7	$ 87.9	$ 84.5	$ 79.9	$ 75.6	$ 91.3
Three year contracts (actual)	$ 95.8	$ 103.2	$ 103.1	$ 101.1	$ 93.1	$ 86.3	$ 81.9	$ 78.1	$ 92.8

It is interesting to note that in the context of decreasing market prices, shorter contracts would have resulted in cheaper cost of supply (on average) over the study period by virtue of following the market conditions more closely. For instance, the historical average cost of supply was $92.8/MWh with three year contracts, while the cost could have been $91.3/MWh with two year contracts and $89.9/MWh with one year contracts.

LEI calculated a hypothetical cost of supply for each scenario and compared one, two or three year FRS contracts (with the corresponding laddering approach). In calculating the future cost of FRS contracts, LEI used the average $9.8/MWh historical risk premium embedded in suppliers' offers. Figure 11 illustrates the anticipated cost of supply procured through FRS contracts of one, two or three year terms.

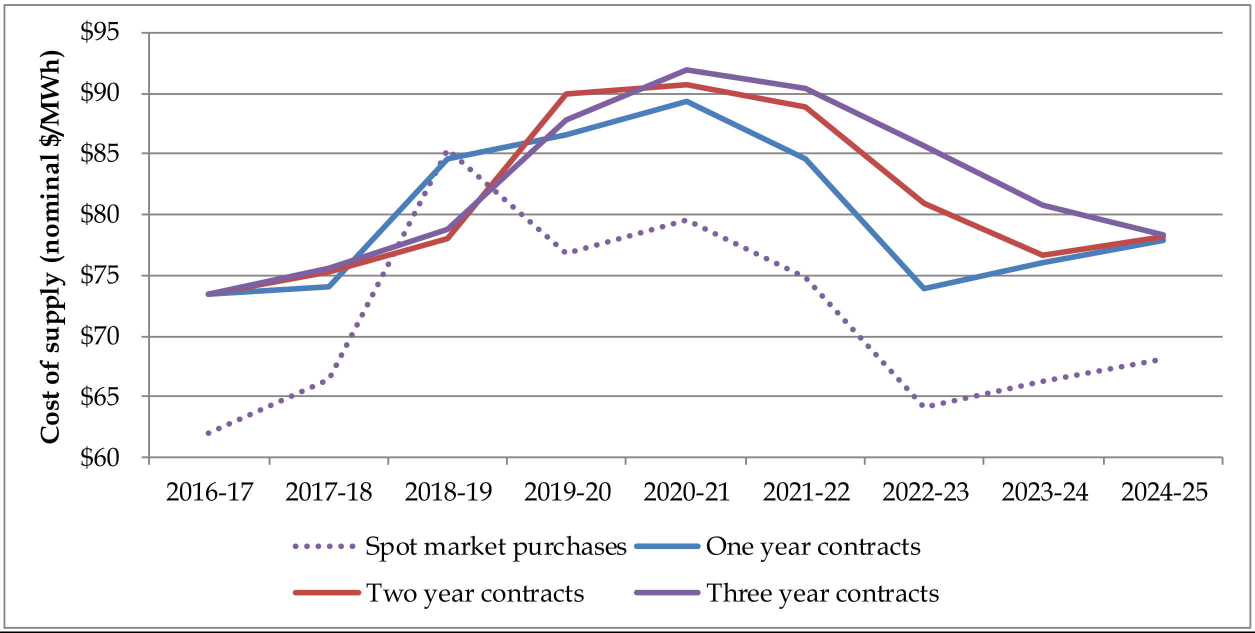
For the Base Case and Low Price scenarios, all three contract term options are priced very similarly over the forecast horizon, since the FRS contracts are expected generally to follow trends in market prices. Variability, however, will change as a function of the different contract lengths and is discussed in Section 4.2.3. For the Price Shock scenario, pricing differs slightly more across different contract terms since LEI assumed the market price differs from expected values under the Base Case.

Figure 11. Hypothetical average forward cost of RSCI SOS supply if purchased for different FRS contract terms under various scenarios (nominal $/MWh)

FRS contract terms	Scenarios		
	Base Case	Low Price	Price Shock
One year contracts	$ 80.9	$ 73.8	$ 80.0
Two year contracts	$ 81.3	$ 74.2	$ 81.3
Three year contracts	$ 81.2	$ 74.1	$ 82.5

Figure 12 illustrates the forecast annual FRS supply cost data from the Price Shock scenario, as compared to supply costs if purchased from the spot markets. The dampening impact of the contract term can be seen through the different curves.

Figure 12. Comparison of FRS supply costs in the Price Shock scenario when compared to spot market purchases (nominal $/MWh)



Note that results of recent FRS auctions, yielding FRS contracts into the 2016-17, 2017-18 and 2018-19 delivery periods, are included in the calculation for the going forward cost of FRS supply.

The costs of purchasing supply from FRS contracts are expressed in dollars per MWh and are based on the Base Case load migration assumptions. The actual migration rate of SOS consumers could affect the risk premium embedded in suppliers' offers, since the risk associated with load uncertainty would increase if load migration picks up. As a result, the risk premium embedded in FRS offers historically could possibly increase, should the migration rate become more volatile.

London Economics International LLC
717 Atlantic Avenue, Suite 1A
Boston, MA 02111
www.londoneconomics.com

4.2.3 Supply cost variability

Although FRS costs are rooted in wholesale market prices, the laddered approach as used by Delmarva has the effect of dampening year-over-year price variations from the spot markets, and ensures a relatively stable cost of supply for RSCI SOS customers.

LEI calculated the variability of supply costs (when procured from FRS contracts) as the standard deviation of the year-over-year supply cost for each contract term option, and under the various pricing scenarios. Figure 13 illustrates the variability of supply costs for all scenarios under one, two, or three year FRS contracts.[32]

Figure 13. Variability of spot market purchases by contract term and scenario (nominal $/MWh)

Scenario	Variability (nominal $/MWh)		
	1 year contracts	2 year contracts	3 year contracts
Historical	$ 8.4	$ 6.3	$ 5.1
Base Case	$ 2.7	$ 2.6	$ 2.3
Low Price	$ 3.1	$ 2.4	$ 2.4
Price Shock	$ 6.1	$ 5.8	$ 4.9

As expected, the longer term FRS contracts exhibit lower variability than shorter term contracts, although the difference in average variability over the 10 year forecast horizon is relatively modest. This relatively small difference can be attributed to the fact that year-over-year difference in FRS auction prices usually stem from changes in fundamental market drivers, which are relatively slow moving, while the more extreme changes from weather conditions are covered through the risk premium embedded in supplier's offers.

Historical variability is relatively high when compared to the forward looking scenarios, ranging from $5.1/MWh for 3 year contracts to $8.4/MWh for one year contracts, due in part to the fundamental changes in market drivers observed in the last 10 years. Furthermore, the Price Shock scenario exhibits the largest variability among the forward-looking scenarios, which is consistent with the large variations in market prices underpinning the scenario. Finally, both the Base Case and Low Price scenarios exhibit the lowest variability, ranging from $2.3/MWh to $3.1/MWh, since the underlying year-over-year variability of spot market prices in both these scenarios is lower than in the Price Shock scenario.

[32] Appendix B (Section 8.2.3) details LEI's methodology for calculating the average FRS supply cost variability.

4.2.4 Administrative cost

Administrative requirements are relatively limited when SOS supply is procured through FRS, as all the requirements of an LSE are passed on to the suppliers.[33] Furthermore, the actual auctions are handled by a third-party supplier through a web-based auction platform. As a result, administrative requirements when procuring supply through FRS include preparing the auction documents (such as the Request For Proposal ("RFP") document, bidder documentation, and FRS agreement), monitoring the auction with a technical consultant, as well as managing the resulting contracts.

The fees of the third party supplier of the auction platform are confidential, but are paid by the winning bidder(s) and as such are assumed to be embedded in $10/MWh risk premium embedded in suppliers' offers. No other fee is assessed to the SOS provider for procuring supply through FRS suppliers.

4.2.5 Other considerations

In addition to cost and variability, there are a number of other considerations which must be discussed when using FRS contracts as a source of supply for SOS consumers. These other considerations, which were discussed in LEI's September 2015 Report, include the amount of load being auctioned off, the timing of the auctions, as well as the type of auction used.

It is important for the amount of load to be auctioned to be large enough so as to attract enough interest from potential suppliers, as the auction participants incur administrative costs in order to qualify and participate in the procurement events. Delmarva currently auctions one third of its RSCI load, which for the 2015-2016 procurement period corresponded to approximately 256.3 MW PLC.[34] The load was divided into 5 blocks, with each block representing around 51.3 MW PLC. As discussed in LEI's September 2015 Report, Delaware's SOS load is smaller than other neighboring states. However, it has usually attracted a sufficient number of participants to ensure the results were competitive, as determined by the independent auction monitor. The load blocks up for auction are close to 50 MW in size, which is consistent with offerings from other states.

Furthermore, the timing of the auctions must be such that the auctions are held as close as possible to the start of the delivery periods so as to reduce the risk to suppliers from the time the offer is submitted to the beginning of deliveries. Delmarva's current auctions schedule divides the procurement into two "tranches", held respectively in late November and early February (for deliveries starting June 1st). The timing of the second tranche is chosen so as to

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33 These requirements are discussed in Section 4.1.3

34 2016 Delmarva Power Delaware SOS RFP – Overview, table 2. web <http://www.pepcoholdings.com/about-us/do-business-with-phi/energy-suppliers/wholesale-suppliers/delmarva-power-delaware-sos/overview/>

allow sufficient time to hold auctions for a third tranche,[35] if necessary, and also allow the winning suppliers to nominate the Auction Revenue Rights ("ARR") to which they are entitled as LSEs.

Finally, Delmarva currently uses a reverse-auction type of procurement, where the suppliers compete among themselves to offer the lowest price for each block. Alternative auction types include the sealed-bid auction and the descending clock auction, the benefits and drawbacks of which were discussed in LEI's September 2015 Report. While performing research for the report, LEI has found no evidence that one procurement method or platform produces systematically better results. However, since several other jurisdictions rely on auctions to procure FRS supply, familiarity with the platform and overall process would appeal to potential bidders. Furthermore, the fee for the auction platform provider, which is embedded in the supply offer, must be compared among the different providers to ensure that the current platform provider fee is consistent with alternative potential providers for this service. As discussed in LEI's September 2015 Report, this process has historically resulted in transparent and competitive auction results.

4.3 Long term contracts

4.3.1 Product characteristics

Long-term contracts encompass a very large array of agreements, from 20-plus year Power Purchase Agreements ("PPA") with new resources being built as a result of securing the contract, to 5-10 year fixed quantity and fixed price agreements for energy and/or capacity.

In the context of SOS supply procurement, LEI considers that the main advantage of a long term contract is to secure a specific amount of supply at a known price so as to ensure stability of cost over the contract horizon. As such, LEI assumed that the SOS provider would contract with one or more resources for a fixed amount of energy and/or capacity, at a price determined in the contract, which may rise at an agreed-upon rate throughout the term, but is not indexed to spot market prices in any way.[36]

For energy, being a fixed quantity of supply, the contract needs to be supplemented by an alternative means of supply to provide the necessary load following. As such, if the SOS provider elects to procure supply through long-term contracts, the likeliest way to provide load-following is to transact in the spot markets to purchase any shortfall of energy/capacity, or to sell potential excess energy/capacity. Therefore long term contracts are assumed to be used

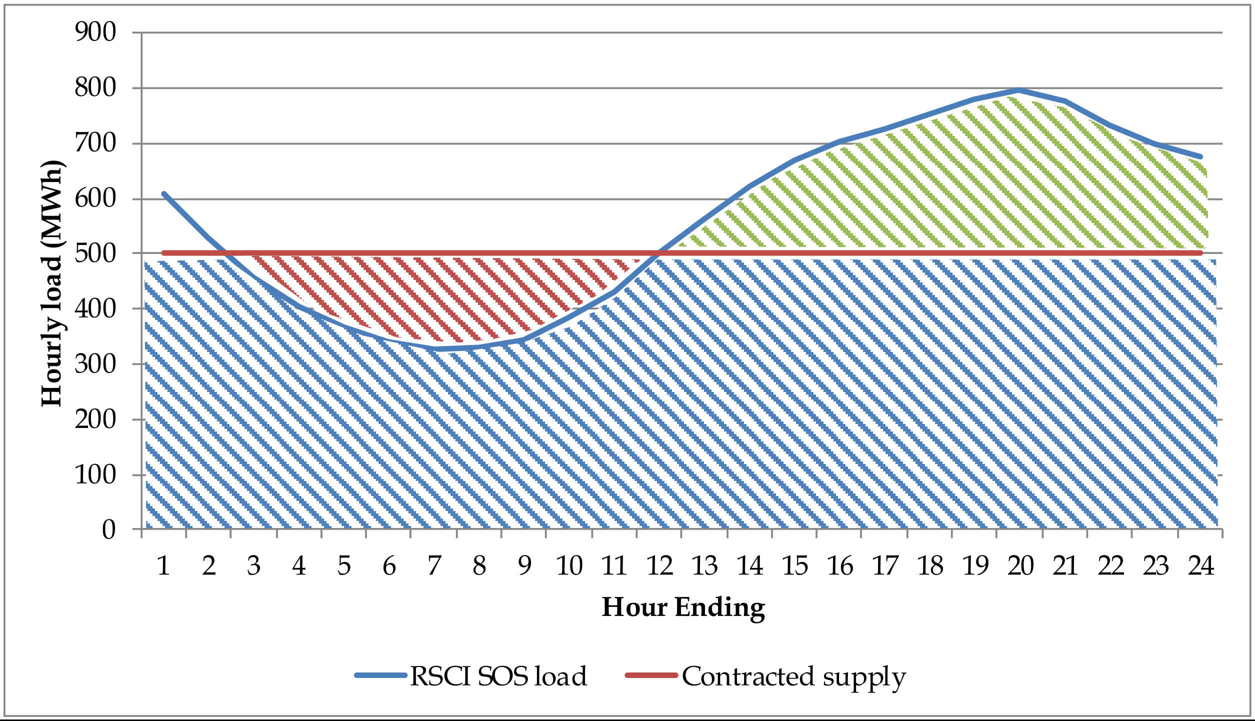
[35] A third tranche auction is held in the event that the first two tranches failed to secure enough supply for the RSCI SOS load

[36] LEI's reference to a long-term contract could also encompass several smaller similar contracts with different suppliers.

as a supply method if part of a portfolio involves purchase and sale transactions in the spot markets.

The size of the contract must also be carefully considered, as larger contracts may actually increase exposure of the SOS provider to spot market purchases. Figure 14 illustrates a hypothetical case where a contract, although representing only a portion of overall SOS load, ends up creating additional exposure to the spot markets for the SOS provider.

Figure 14. Illustration of load hedging using long term contracts



In this hypothetical example, the contracted energy quantity is fixed at 500 MW. As a result, all hourly load under 500 MWh is hedged by the contracted energy, as demonstrated by the shaded blue area. Supply for load above the contracted quantity, represented by the green shaded area, must be procured through other means, for instance purchased through the spot markets. Finally, for those hours when load is below the contracted quantity, as illustrated by the red shaded area, excess supply must be resold in the spot markets. During those hours, the contract would essentially become speculative, with the SOS provider arbitraging the contract and spot market prices.

An LSE's capacity requirement is much larger than the energy requirement, since the installed capacity requirement represents the PLC of RSCI SOS load plus PJM's installed capacity requirement, as discussed further in Appendix B (Section 8.1.1).[37] As a result, a contract for energy and capacity designed to hedge a certain percentage of the energy cost will also result in capacity cost hedging, but for a much smaller percentage.

In the context of the Delaware RSCI SOS load, LEI calculated the energy and capacity hedging factor[38] of various contract sizes under different procurement scenarios. LEI further calculated the expected amount of excess contracted supply for various contract sizes considering the RSCI SOS load forecast. These calculations are detailed in Appendix B (Section 8.3.1), and are used in selecting appropriate contract sizes as discussed later in Section 5.2 and Section 5.5.

Overall, since the energy and capacity requirements are different, a combination of energy only, capacity only, or combined energy/capacity long-term contracts can be used to procure the appropriate quantities of each product to implement a particular hedging strategy.

In terms of contract duration, LEI considered terms ranging from 5 years to 20 years or more. However, while contract lengths beyond 10 years are often useful for getting new resources financed and built, LEI considers that it is unnecessarily long in the context of SOS supply procurement. This could lead to increased risk to the SOS provider from load deviation from expectations, and price divergence from the contracted price. Similarly, shorter contracts would limit the price stability effect of the contract. As a result, LEI assumed contract durations of 10 years for energy and capacity contracts as a reasonable compromise between price stability and the risk due to contracted terms diverging from load requirements and market conditions.

Similar to the approach currently used by the SOS provider for the procurement of FRS supply, laddering can be an effective strategy to reduce the risk associated with load variations and price divergence. For instance, 50% of the contracted supply requirement could be procured every five years through contracts of 10 year term. This method would reduce the variation in supply costs when the 10 year contracts need to be renewed.

4.3.2 Supply cost

As discussed in the previous section, LEI assumed contract terms such that the energy and/or capacity prices may rise at an agreed-upon rate throughout the term, but are not indexed to market prices.

In calculating hypothetical contract costs, both for the historical and forward-looking scenarios, LEI assumes that energy and capacity prices for long term contracts are consistent with energy and capacity market expectations at the time the contracts are signed. Considering the fixed-

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[37] As PJM relies on a sloped demand curve in the BRA, the actual amount of capacity purchased can end up being slightly smaller or larger than the capacity requirement

[38] The hedging factor is the percentage to which the overall energy or capacity supply requirement is hedged through fixed price, fixed quantity contracts.

quantity nature of the contract, in a market the size of PJM, and with a well-structured competitive process, LEI believes it is possible to secure long-term, fixed-price contracts at prices consistent with market expectations over the contract horizon. This outcome is consistent with rational behavior for buyers and sellers, which includes generators or marketers looking to hedge a portion of their output.[39]

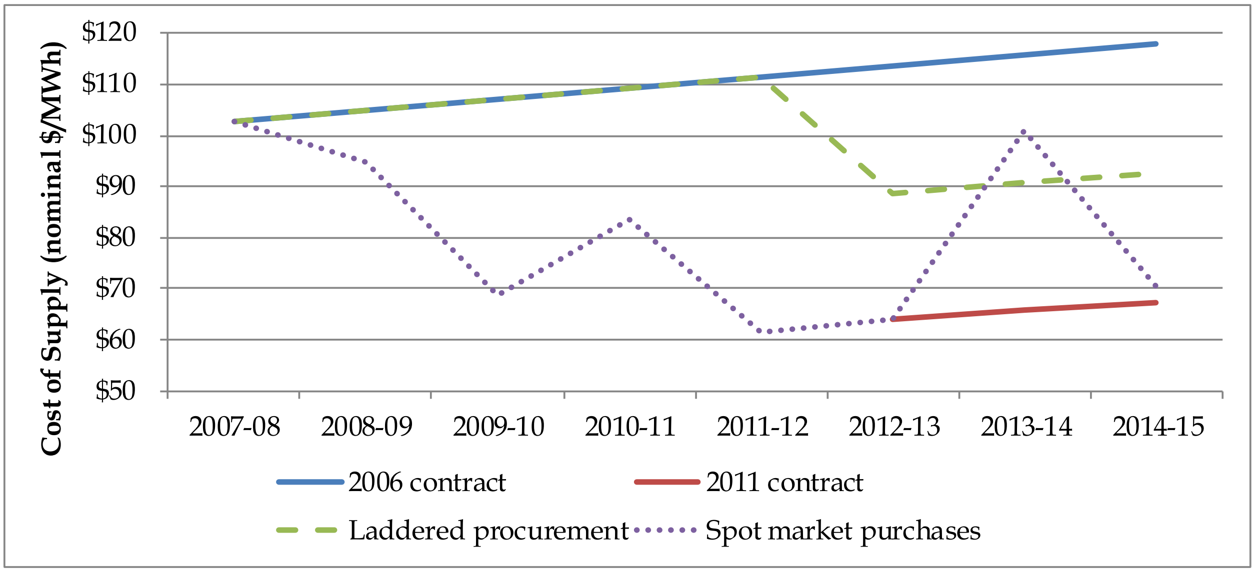
Figure 15 illustrates the hypothetical cost of supply from long term contracts from a historical perspective, with the cost of supply if purchased from the spot markets added to the graph for comparative purposes (purple dotted line). As mentioned in the previous section, however, long term contracts must be combined with another procurement method to provide load-following. The average combined cost of this approach will be discussed in Section 4.5. The figure below only illustrates the average cost of the contract.

The blue line illustrates the cost in dollars per MWh of supply from hypothetical 10 year contracts for energy and/or capacity signed in the 2006 timeframe (plus the cost of ancillary services and other ISO fees) and featuring a 2% inflation, which is consistent with long-term market expectations at the time. The red line illustrates the same concept, but for contracts signed in the 2011 timeframe. Prices for contracts signed in the 2011 timeframe would have been lower than contracts from the 2006 timeframe since the market expectations then included the effects of the reduced demand from the 2008-09 recession, as well as the lower outlook for natural gas prices due to the emergence of shale gas. The dashed green line illustrates the hypothetical laddering of contract procurement (equivalent to the laddering of FRS contracts). In 2006, half of the contracted supply is procured for a period of 10 years, while the other half is procured for a period of 5 years; in the 2011 timeframe, the expiring 5 year contract is replaced by a 10 year contract for the same quantity of energy and capacity.

As expected, the hypothetical cost of long term contracts is higher in the 2006 timeframe, before the advent of lower priced shale natural gas and the economic recession. As a result, a contract concluded in that period would have become “out of the money”, meaning the actual realized market prices fell below the contract price with time. In contrast, contracts signed in the 2011 timeframe would reflect the newer expectations for lower wholesale market prices. As a result, in the context of falling historical prices, a laddered approach to procuring contracted supply would have proven more prudent than purchasing the whole contracted supply quantity for a duration of 10 years back in 2006.

[39] Appendix B (Section 8.3.2) details LEI’s methodology for calculating the average cost of contracted supply.

Figure 15. Historical cost of supply from long term contracts (nominal $/MWh)



Contract timeframe	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	Average
2006 contract	$ 102.8	$ 104.8	$ 106.9	$ 109.1	$ 111.2	$ 113.5	$ 115.7	$ 118.1	$ 110.3
2011 contract						$ 64.1	$ 65.7	$ 67.3	$ 65.7
Laddered procurement	$ 102.8	$ 104.8	$ 106.9	$ 109.1	$ 111.2	$ 88.8	$ 90.7	$ 92.7	$ 100.9

LEI's Base Case scenario corresponds to the current market expectations for energy and capacity prices. As such, we assume that any contract signed in the near future would have pricing terms that reflect such expectations, irrespective of the actual realized prices in the future. Similarly, any contract signed five years in the future would reflect the market expectations at that time. In that context, should the actual 2016-2020 market trajectory be consistent with the Low Price or the Price Shock scenario, the contracts signed 5 years in the future would reflect the modified expectations for market prices at that time. Figure 16 illustrates the anticipated cost of contracted supply at different points in time and under the different market pricing scenarios.

Figure 16. Hypothetical forward cost of RSCI SOS supply if purchased through long term contracts for various scenarios (nominal $/MWh average over 2016-17 to 2024-25 horizon)

Contract timeframe	Base Case	Low Price	Price Shock
2016 contract	$ 65.6	$ 65.6	$ 65.6
2021 contract*	$ 68.9	$ 61.9	$ 63.6
Laddered procurement	$ 65.6	$ 64.1	$ 64.5

* average cost over 2021-22 to 2024-25 period is shown

For all scenarios, the average price for contracted supply procured in 2016, in dollars per MWh (which includes contracted energy and capacity, and ancillary services plus other ISO fees purchased from the spot markets), is consistent with the Base Case market expectations and represents $65.6/MWh. However, contracts executed five years into the future would be expected to reflect the revised market trajectories. For instance, in the Low Price scenario, new contracts signed in the 2021 timeframe would reflect the much lower price expectations. As such, a laddered procurement approach would allow for a modest adjustment to market conditions, although these remain 10 year, long term contracts which are primarily designed to provide price stability. As a result, for the Low Price scenario, the laddered approach would result in the average cost of contracted supply being lower than if all contracted supply had been procured around 2016. The effect of the laddering is understated though because laddering does not start until midway through the forecast horizon.

4.3.3 Supply cost variability

As explained in the previous section, long-term contracts are assumed to be fixed-price, where the price modestly but steadily increases throughout the length of the contract. As such, this supply procurement method does not exhibit any variability.

4.3.4 Administrative cost

Long-term contracts can be procured through an RFP similar in many ways to the auctions currently used for FRS supply. More generally, Delmarva has experience with long term PPAs, for instance for the procurement of RECs from renewable resources. Furthermore, since the RFP is requiring a standard product in the form of energy and/or capacity, a standard agreement can be developed beforehand (again, much like the solicitation for FRS). Likewise, credit requirements should not be materially different than they are for current contracts that Delmarva has entered into, which include FRS contracts as well as long-term contracts for RECs.

Management of the contract throughout its life also should not be materially different from managing the existing FRS or REC contracts. As such, LEI does not consider that long-term contracts for energy and/or capacity would place an additional administrative burden on Delmarva, the SOS provider.

4.3.5 Other considerations

As shown earlier in Section 4.3.1, the average RSCI SOS capacity requirement in MW is different than the average energy requirement. As such, if the SOS provider wishes to hedge a target percentage of both energy and capacity costs, it will need to procure different amounts of energy and capacity. Therefore, as noted previously, a solicitation for long term contracts could include a request for energy, capacity, or combined energy/capacity contracts, where suppliers submit the quantity they are willing to provide along with the price offer. The SOS provider would then select the best offers up to the amount of each product required.

The solicitation could be done through a sealed-bid process, where suppliers submit their offers independent of one another. Alternatively, the existing reverse auction mechanism could be used to auction off "blocks" of energy and capacity. Some adjustments may be required to the rules in recognition of the non-substitutability of energy and capacity offers in order to limit gaming.

In calculating the cost of supply for contracted energy and capacity supply, LEI has assumed that the products would be delivered to the DPL zone. However, the SOS provider could alternatively seek energy deliveries to a widely traded hub, such as the Western Hub, or capacity deliveries in one of the parent PJM capacity zones, such as MAAC or RTO. The drawback of seeking deliveries outside of the DPL zone is that the SOS provider could be exposed to the energy and capacity price difference between the DPL zone and the delivery point. In the case of energy deliveries, the risk can be mitigated through ARRs. However, for capacity, there is no "congestion" hedging mechanism currently available in the PJM capacity markets. On the other hand, seeking deliveries at widely traded hubs or zones could open up the field of suppliers willing to submit an offer and expand competition, which could ultimately lower the cost of supply.

The overall solicitation process would be similar to that currently used to procure FRS. An independent examiner could be tasked with ensuring that the process is competitive and that results are consistent with the expected market conditions.

There are several options for drafting the contracts resulting from the solicitation. One such option could be to keep the terms purely financial (akin to a derivatives contract). This option could open bidding to marketers without physical assets. There are, however, administrative and credit requirements associated with regulatory oversight of these contracts. Another option in the energy market is the use of bilateral transactions for the purchase of energy, such as Internal Bilateral Transactions, which allow for the physical transfer of energy to or from a Market Participant.

For the capacity markets, the bilateral transactions are called "Bilateral Capacity Transaction Transferring Title to Capacity But Not Transferring Performance Obligations",[40] also referred to as "Section 4.6(b) Bilateral". These bilateral transactions between two PJM market participants for the physical purchase and sale of capacity that has cleared a capacity market auction allows the buyer to obtain the rights and title to the cleared capacity.[41] [42] [43]

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[40] PJM OATT, Attachment DD, Section 4.6(b)

[41] However, following the creation of the capacity performance product, PJM has reviewed the current OATT tariff language and concluded that it does not clearly address several important details related to bonus payments, and indemnification (as may be impacted by replacement transactions). PJM further cautions market participants of risks as to how such transactions may be treated in litigation or bankruptcy until these issues are resolved through Tariff revisions. PJM anticipates future discussion of this issue in various stakeholder committees and a FERC filing 6-8 months from endorsement of the Problem Statement and Issue Charge. This issue must therefore be followed closely. If however the SOS provider should decide to enter into a long term contract before this issue is fully resolved, additional legal language must be inserted

4.4 Buying or building own generation resources

Purchasing or building its own resources was identified as a potential method for the SOS provider to procure supply for its load. LEI also includes the option of a long-term PPA for a new plant's output in this category. However, there are several factors which make this option unattractive for Delmarva and Delaware SOS customers. As such, LEI did not evaluate this option in the following discussion and ultimate recommendation for SOS supply procurement.

Among the existing generation technologies available, gas-fired CCGTs is the most cost-effective available technology. Simple cycle gas turbines are less expensive to build but more expensive to operate, and as such are generally better suited as peaking units providing mostly energy during peak conditions and capacity value.

Wind power plants could be attractive, but the intermittent output and low capacity factor would require greater reliance on spot markets than the output of a dispatchable resource. Furthermore, the location of the wind resource may result in the energy being delivered far from the DPL zone, increasing congestion risk in the energy and capacity markets. Finally, wind resources are derated in the capacity markets to a fraction of the nameplate rating in order to account for their expected output during high load hours.

The large majority of new Combined Cycle Gas Turbines ("CCGT") built in PJM since 2002 have been in the 500 MW to 700 MW range,[44] which is significantly larger than the RSCI SOS load. While it is possible to build smaller plants, those smaller units would not benefit from the economies of scale enjoyed by the larger plants and therefore cost more to develop per MWh of output. Assuming that the generation resource has a fixed output, and as discussed in Appendix B (Section 8.3.1), a 200 MW unit would serve approximately 60% of the RSCI SOS supply with load-following provided through spot market purchases. Attempting to build a larger unit to benefit from economies of scale would result in a significant portion of the plant's output sold in the energy markets, thus increasing the speculative portion of the plant's output. Using the plant to serve a set percentage of SOS load, thus performing the load following, would not be efficient as the constant variation of output might stress the plant and cause

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into the contract to clarify the terms related to the Capacity Performance risk, including bonus payments and indemnification.

42 PJM, *Statement Concerning Auction Specific Bilateral Transactions*, Market Implementation Committee, February 5, 2016.

43 PJM, *Auction Specific Bilaterals Issue Charge*, Market Implementation Committee, March 10, 2016.

44 The Brattle Group, Sargent & Lundy, *Cost of New Entry Estimates for Combustion Turbine and Combined Cycle Plants in PJM*, table 7, page 9, May 2014. Web. < https://www.pjm.com/~/media/documents/reports/20140515-brattle-2014-pjm-cone-study.ashx>

unplanned outages. Furthermore, the average capacity factor of the plant might be reduced, resulting in degraded thermal efficiency and unused generation capacity.

Another drawback of the SOS provider owning generation resources is associated with the operation of the plant itself. Delmarva may not have the expertise to run a generation plant, and would therefore need to hire a third party operator. Operational and financial risks would still exist, such as plant outages and costs of maintenance. Other risks involve the procurement of fuel, which also requires expertise. While that expertise can also be hired out, if operational and financial risks are borne by the third parties, their fee would include a risk premium. Finally, the SOS provider, as owner of a single resource, would not benefit from the economies of scale and risk management expertise of large generation owners with significant generation portfolios.

A long term PPA to incentivize the construction of a new plant also has some challenges for the SOS supplier. As discussed previously, the small size of Delaware RSCI SOS load is a key factor. Also, PJM's tariff includes buyer side mitigation rules which in essence require a generator to offer capacity in the RPM at a price representative of their true going-forward costs, excluding revenues from contracts with regulated entities.[45] As such, the SOS provider would bear significant regulatory and economic risks if building or owning its own generation.

4.5 Supply procurement portfolios

As each procurement method described in previous sections has specific merits and drawbacks, there may be benefits for the SOS provider in combining different percentages of supply procured from the individual procurement methods into a procurement portfolio. The portfolio approach would reduce dependency on any single procurement approach and combine the overall cost and variability characteristics of the various procurement methods. However, we recognize that a portfolio approach would increase the administrative requirements and costs versus relying on a single procurement approach.

In addition to purchases from the spot markets and FRS contracts of various lengths, LEI considered portfolios including the following combinations of procurement methods:

- Long term contracts plus spot market purchases;
- FRS contracts and spot market purchases; and
- FRS contracts, long term contracts, and spot market purchases (with varied percentages of supply procured from each procurement method).

When assessing hypothetical portfolios on a historical basis, LEI generally used a weighted average of supply costs for each procurement method in the portfolio for a particular delivery

[45] PJM OATT Attachment DD § 5.14(h)

period. Then LEI calculated the average cost of supply over the historical 2007-08 to 2014-15 timeframe, as well as the variability of portfolio supply costs. The exception to this approach is the combination of long-term contracts and spot market purchases. Since the contracted amount of energy is constant while the load varies, LEI performed an hourly calculation to estimate the amount of additional supply purchased from the spot market (or the excess contracted supply sold into the spot market), and the corresponding energy price.

On a forward-looking basis, LEI used a similar approach and calculated the average supply costs for a given portfolio as the weighted average of costs for each procurement method in the portfolio.

In application of financial theory, the overall variability of a supply procurement portfolio is a function of the variability of the portfolio components, as well as the measure of how much the average annual cost of supply for different procurement methods change together. The portfolio variability calculation is further detailed in Appendix B (Section 8.4.2).

4.6 Summary

Figure 17. Summary of alternative procurement method characteristics

Procurement method	Supply cost	Supply cost variability	Administrative cost
Spot market purchases	No intermediary ensures that SOS supply costs reflect prices of the wholesale power markets	High variability of power market prices is transferred to SOS customers	Administrative requirements of participating in the PJM markets may include placing bids in the DA market, credit requirements, accounting and settlement requirements, or hiring a third party to perform such duties
Full requirement service	Fixed-price multi annual contracts might cause a discrepancy between supply costs and underlying wholesale market prices, while the risk premium embedded in suppliers' offers may result in cost of supply which are higher than other methods of procuring supply	Fixed-price multi annual contracts ensure that there are no large year-over-year variations in cost of supply, and variability of supply costs can be adjusted through the term of the FRS contracts	Administrative requirements are relatively low, with all duties and risks associated with status as a Market Participant shifted to the FRS suppliers
Long term contracts	Fixed price long term contract pricing terms are are expected to reflect the expected market conditions at the time of execution, but may diverge over time from the prices of underlying wholesale market conditions	Variability of supply costs is very low as the contract price is fixed for a long (ten year) period	Administrative requirements for long term contracts are similar to FRS supply, as the method of procuring supply and subsequent administration of the contracts is similar
Supply procurement portfolios	Portfolio supply costs depend on the combination of procurement methods, and risks can be mitigated through spreading the supply requirement through multiple procurement methods	Portfolio allows the variability of supply costs to be adjusted through the ratios of supply procured from each procurement method	Administrative requirements would potentially be higher when a supply procurement portfolio is used when compared to a single procurement method, since the portfolio would combine the administrative requirements of multiple procurement methods

Figure 17 provides a summary of the characteristics of alternative procurement methods or portfolios for SOS supply, excluding the option of purchasing or building generation resources for the reasons mentioned previously. The metrics that LEI discussed for this comparison include the average cost of supply, as well as the variability, or standard deviation of year-over-year variations, in supply costs. LEI also assessed the administrative requirements that would be associated with the procurement methods of with a portfolio approach.

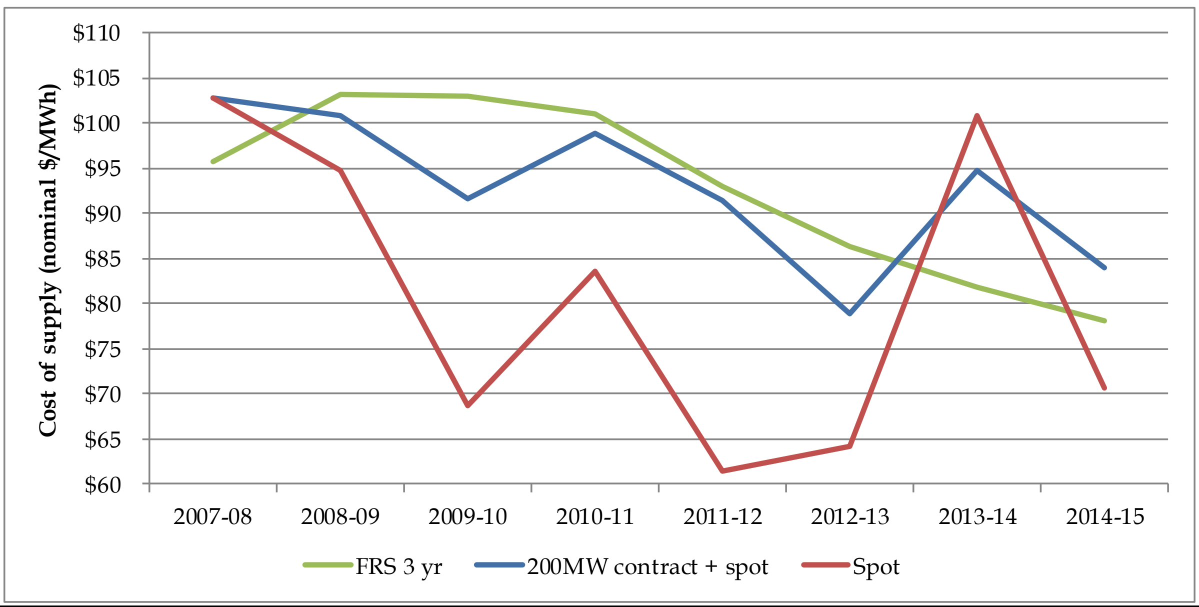
5 Comparison of procurement methods

FRS procurement, long term contract procurement and purchases from the spot markets each have different advantages and drawbacks in terms of average supply cost, variability of supply cost, administrative requirements, or ease of implementation. As such, the metrics LEI used to perform a quantitative analysis and comparison of these procurement methods are the average cost of supply in dollars per MWh, and the average variability of the supply costs, also denominated in dollars per MWh.

For instance, while FRS procurement with a laddered approach yields a low variability of costs, the risk premium embedded in the supplier offers would tend to result in average costs higher than purchases from the spot market. Long term contracts, on the other hand, can provide price stability and low prices, but represent fixed quantities and fixed prices. As a result, a deviation in wholesale market conditions from the expected trends, or a change in RSCI SOS load from the IRP forecast, could result in contracted supply costs not reflecting actual market conditions, or a percentage of load covered by the contracted supply being significantly higher than intended.

Figure 18 compares the historical annual cost of supply from different procurement methods[46], calculated as discussed earlier in Sections 4.1 to 4.3.

Figure 18. Historical annual cost of supply for procurement methods



[46] Actual cost for FRS procurement, hypothetical cost for other procurement methods

From the above graph, the variability of supply costs when purchased solely from the spot markets is apparent. Conversely, FRS supply costs using three year contracts are much more stable than spot market purchases, but higher on average. Adding long term contracted supply to procurement from the spot markets will result in prices somewhere in between FRS and spot market purchases, but result in an increased exposure to market prices diverging from expected conditions at the time the contracts were signed (as observed for the historical period). This approach would also create exposure to the actual RSCI SOS levels, as the contracted amounts are fixed.

In addition to relying on individual procurement methods, using a combination of different procurement methods could result in lower overall supply costs while keeping the variability within reasonable bounds, and lowering the portfolio's exposure to pricing trends or load levels diverging from the forecast values.

5.1 SOS procurement evaluation criteria

In the September 2015 Report, LEI introduced a set of evaluation criteria from which to assess Delmarva's current procurement methodology with respect to alternative approaches. These criteria were selected pursuant to best practices for analysis of any regulatory or market design initiatives/changes, and encompass Delaware-specific policy goals. The proposed criteria include:

Efficiency and consistency with competitive markets

The auction process can be considered efficient if it results in prices comparable to those in competitive wholesale markets for the products being purchased on auction. LEI's definition of wholesale markets is not limited to prices in PJM's spot market for energy, but also includes bilateral contracts. Results from a solicitation for long-term power through a bilateral contract can be reflective of wholesale competitive markets if the solicitation was performed in a manner that allowed competition among potential counterparties.

Furthermore, this criterion also addresses competitive retail markets, as that has been mandated in Delaware. Therefore, as part of this metric, LEI considers the effect of a proposed change on the development of a competitive retail market within the state of Delaware.

Balancing benefits and costs to ensure the least cost to consumers

An efficient auction process needs to be transparent, such that it supports competition, minimizes risks and results in least cost to consumers that are commensurate with risks. Transparency in this context ensures that the procurer and sellers are each aware of the benefits and costs associated with participating in the auction. As such, potential suppliers should be able to factor such costs and benefits in developing their bids. Balancing of benefits and costs also means that the prices faced by consumers should be consistent with inherent risks and cost of supply.

Consistency with overall Delaware policies and goals
Delaware's policy goals emphasize stable prices at the lowest possible cost. Furthermore, the procurement process should result in reliable supply of electricity both in the short and the long term.
Ease of Implementation
Implementation of alternative procurement methodologies is already feasible in Delaware by the EURSCA Act of 2006, which allows flexibility to the SOS provider in choosing its sources of supply (as long as 30% is procured through competitive RFPs or auctions). Notwithstanding the legislated flexibility, different procurement constructs, including different processes, formats, and product/auction characteristics can have varying levels of regulatory requirements or administrative burden(s) for the SOS provider, as well as different implementation costs.

5.2 Spot market purchases

Purchasing supply from the spot markets represents the best way to achieve efficiency and consistency with competitive markets, as the SOS supply costs directly reflect underlying spot market electricity costs. Procurement from the wholesale markets is consistent with competitive markets because it essentially relies on the auctions that PJM manages to determine the LMP for energy, as well as the other auctions PJM runs for ancillary services and capacity.

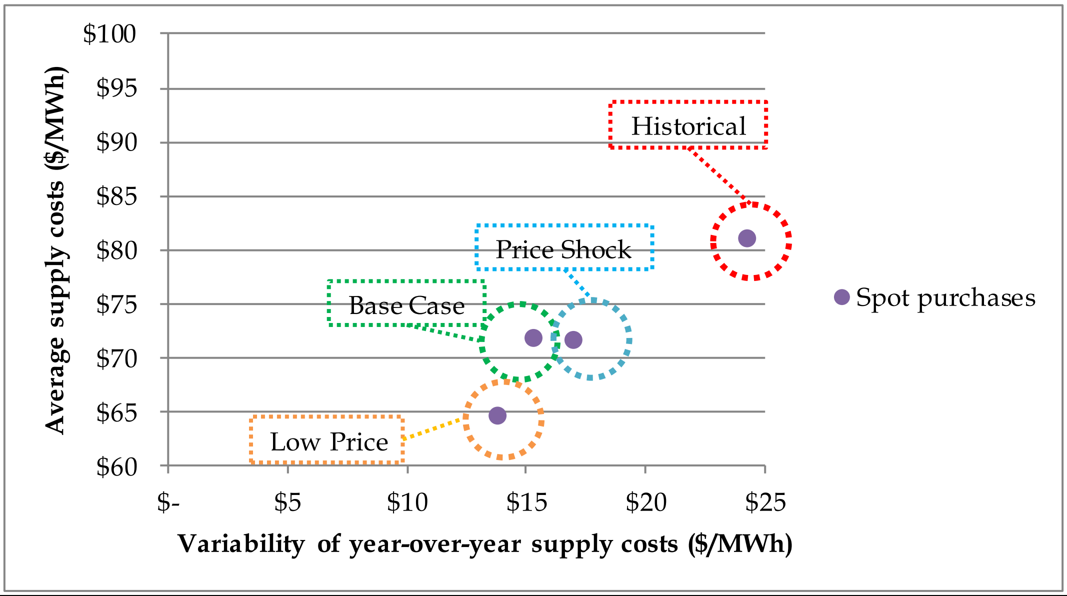
This approach for procurement of SOS would potentially help spur competitive retail markets as it creates a price to beat for retailers who are tracking their opportunity costs closely. As such, the volatility in LMPs creates incentives where consumers may like to switch from SOS to competitive retailers. Furthermore, the exposure to wholesale prices may stimulate consumers to invest in energy efficiency measures and conservation.

Supply costs when purchased from the spot markets would not include any additional risk adders, but would exhibit the inherent volatility of market prices. Figure 19 illustrates the average cost of supply when purchased through the spot markets (on the vertical axis) with respect to the variability of supply costs (on the horizontal axis), for all the pricing scenarios. As the average prices for the historical period were higher than the average prices of the forecast scenarios, the cost of supply if purchased through the spot markets is the highest (on the vertical axis) for the historical scenario in Figure 19. Conversely, the Low Price scenario results in the lowest average cost of supply if procured through the spot markets. The Base Case and Price Shock scenarios result in similar average supply costs, in between the Low Price and historical scenarios.

Similarly, the historical scenario results in the highest (on the horizontal axis) variability of supply costs for supply purchased from the spot markets. The Price Shock scenario exhibits a lower variability of costs than the historical scenario, but higher than the Base Case. Finally, the Low Price scenario exhibits the lowest average variability of supply costs.

The hypothetical historical cost of procuring electricity supply for RSCI SOS customers would have averaged $80.8/MWh over the 2007-08 to 2014-15 period, but the standard deviation of year-over-year costs (i.e. variability) would have been $24.4/MWh. For comparison purposes, the actual cost of SOS supply procured through three-year FRS contracts averaged $92.8/MWh, with a variability of $5.1/MWh. Spot market purchases would therefore have represented a $12.0/MWh reduction in supply costs, but an increase of $19.3/MWh in variability. Put differently, when comparing spot market purchases with FRS procurement, supply costs would only decrease by $0.6/MWh for each $1.0/MWh increase in the variability of supply costs, which means that variability would increase more than costs would decrease

Figure 19. Comparison of cost vs variability for spot market purchases for all scenarios



On a forward looking basis, using the Base Case scenario, the costs of SOS supply procured through the spot markets would average $71.6/MWh with a variability of $15.4/MWh, compared to average costs of $81.2/MWh and a variability of $2.3/MWh for three-year FRS contracts. This represents an average $9.6/MWh reduction in supply cost versus FRS and a $13.1/MWh increase in variability, or a decrease in supply costs of $0.7/MWh for each $1.0/MWh increase in variability with respect to the FRS procurement. Since the quantities of supply purchased from the spot market correspond exactly to the load requirements, the SOS provider does not bear any risk associated with load and as such, on average over the forecast horizon, this approach is expected to yield the lowest cost of supply (but largest variability of cost) for the Low Price, Price Shock, or High Migration scenarios with respect to other methods of procuring supply (for a complete comparative discussion, see Section 5.5).

Purchasing power from the spot markets would fit within the current legislative framework for the SOS provider, and would satisfy the requirement that at least 30% of supply come from the competitive marketplace. This approach is also transparent as wholesale market prices are public. When spot market prices are relatively low and static, both the customers and the suppliers benefit from clear, transparent purchase of low cost power. However, the calculated historical and forecast variability associated with spot market prices would not assist in meeting Delaware goals of stable prices.

If the SOS provider does not have the resources necessary to participate in the wholesale markets, it is possible to subcontract the scheduling functions to a third party who would be responsible for entering bids in the PJM markets and generally perform the duties of a market participant. Other administrative requirements for purchasing power from the spot markets are not particularly different than the accounting necessary to keep track of FRS contracts.

In conclusion, while this approach would satisfy several of the evaluation criteria such as transparency, consistency with the competitive markets, or ease of implementation, the extreme variability of wholesale market costs is not consistent with the desire for stable supply costs and would not balance effectively the benefits to consumers, such as lower costs, with the risks associated with variability of prices. As such, LEI would not recommend that purchases from the spot market be the primary means of procuring supply for the RSCI SOS load.

5.3 Full Requirement Service

Delmarva's current RSCI procurement method relies on three year, fixed price FRS contracts and a laddered procurement approach where contracts representing supply for a third of the RSCI SOS load are renewed every year, using a reverse auction mechanism to select the lowest price suppliers. Since the FRS contracts are fixed price and suppliers are responsible for a given percentage of the SOS load, this approach allows the SOS provider to transfer all risks associated with load variation and price variations to the FRS suppliers.

Participants to the SOS provider's supply auctions are market participants within PJM, and their opportunity costs are based on future energy, capacity and ancillary services costs from the PJM wholesale markets. It is therefore fair to assume that, in a competitive environment, supply offers will tend to reflect costs from these wholesale markets, with adjustment for risks.

However, while purchases from the spot market directly reflect the underlying costs of power, the three year, laddered approach to FRS procurement that Delmarva has employed tends to result in prices that do not necessarily reflect the current market conditions. As such, this can create a "boom and bust" cycle where competitive supplier rates are sometime competitive with SOS rates, but other times much more expensive. This behavior will adversely affect the development of robust competition in the retail market.

With FRS contracts, all load variation, market price, and regulatory risks are shifted from the SOS provider and its ratepayers to the SOS suppliers. This transfer of risk from the SOS provider to the FRS suppliers, however, comes at a cost. In anticipation of market price, load, weather, or regulatory uncertainty, suppliers will build a margin in their fixed price offers to account for risks, which may then mean that the fixed supply costs paid by SOS RSCI customers may end up higher than realized wholesale market costs. For instance, the regulatory uncertainty leading to the creation of the CP product in PJM's capacity market together with the three year commitment required of FRS suppliers is said to have caused a decline in supplier participation for the 2014-15 procurement process. LEI did observe that the risk premium embedded in suppliers' offers was higher in that procurement process as compared to the average in prior years, as illustrated in Figure 33 (page 83).

LEI has calculated that historically, on average, FRS suppliers have embedded in their offer a risk premium corresponding to $10/MWh with respect to the anticipated cost of supply from the wholesale markets at the time the offer was made.[47] Furthermore, comparing the historical costs of the FRS supply to consumers with the realized underlying costs of power in the wholesale power markets, the premium paid by SOS customers ended up representing $12.0/MWh. This difference in cost can be attributed in part to the risk premium embedded in suppliers' offers, but also to the downward trend in historical prices over the period, and the lag with which FRS prices follow market prices induced by the laddering approach.

However, while supply costs may be higher with FRS contracts, these contracts are an effective way to shield RSCI SOS customers from historical volatility in spot market prices. For the historical 2007-08 to 2014-15 period, LEI calculated the average variability as $5.1/MWh, as opposed to $24.4/MWh for spot market purchases.

While Delmarva has historically relied on three year laddered FRS contracts, the contract length will affect the cost and variability of FRS procurement. With one year FRS contracts, the entire RSCI SOS supply requirement would be purchased annually. With two year FRS contracts, half of the RSCI SOS supply requirement would be purchased annually. As a result, while suppliers are bound to their fixed price offer for a shorter amount of time with shorter contracts, the risk due to weather is higher since there are less opportunities to average out the weather-driven price differences. For these reasons, LEI assumed that the risk premium embedded in supplier offers for one to three year FRS contracts would be similar.

However, probably more so than the risk premium differences between one to three year contracts, the trend in market conditions will affect supply cost and variability for FRS procurement. Figure 20 and Figure 21 illustrate the average cost of supply when purchased through the spot markets (on the vertical axis) with respect to the variability of supply costs (on the horizontal axis), for the historical period (Figure 20) and all forecast scenarios (Figure 21). The various pricing scenarios result in different costs of supply and variability of supply costs for the various FRS contract terms, even though the risk premium is assumed to be identical for all three contract terms considered.

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[47] Details of the embedded risk premium calculation are discussed in Appendix B (Section 8.2.1)

Figure 20. Comparison of cost vs variability for FRS contract length options for historical period

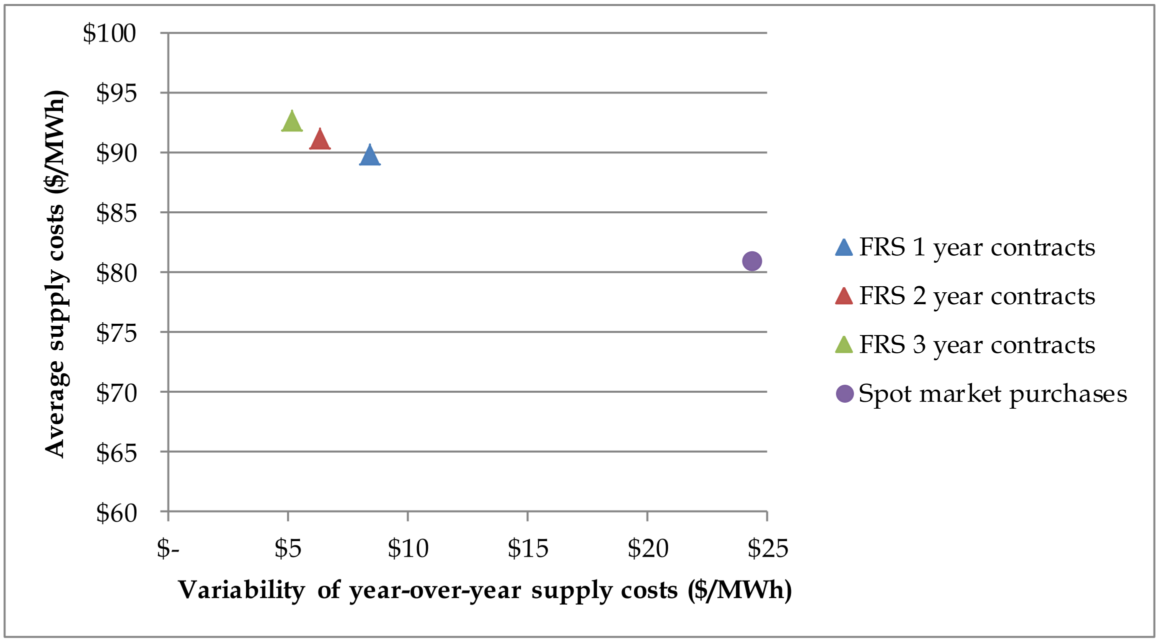
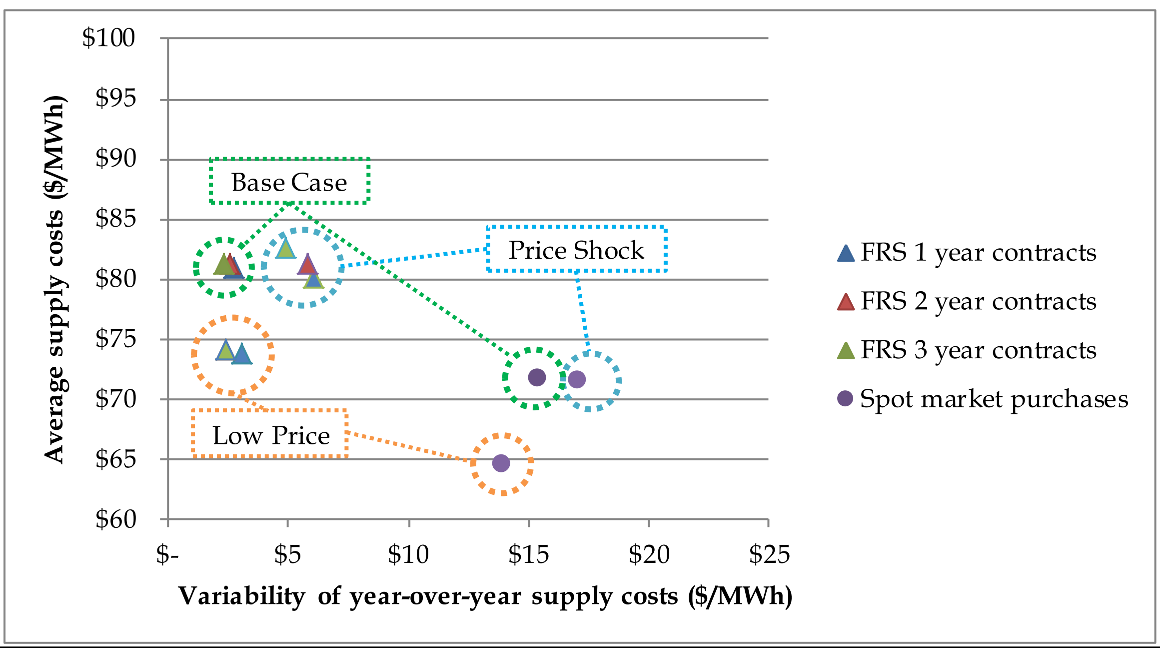


Figure 21. Comparison of cost vs variability for FRS contract length options for forward looking scenarios



Historically, since wholesale market prices on average came down from their level of 2007-08, FRS auction results have generally reflected that trend. However, because of the three year laddering, the decline in SOS supply costs has lagged behind the decline in wholesale market prices. Shorter contracts, on the other hand, would have allowed for a relatively quicker alignment of FRS supply costs to market prices (as was illustrated earlier in Figure 10).

In that particular context, the resulting average cost of FRS with three year contracts was $92.8/MWh. LEI calculated that hypothetical two year FRS contracts would have resulted in average supply costs of $91.3/MWh, while hypothetical one year contracts would have cost on average $89.9/MWh. Variability, as expected, would have increased from $5.1/MWh for three year contracts to $6.3/MWh and $8.4/MWh, for two year and one year contracts respectively. As such, using two year instead of three year contracts would have resulted in a decrease in costs of $1.5/MWh for each $1.0/MWh increase in variability. Similarly, using one year instead of three year contracts would have resulted in a decrease in costs of $0.9/MWh for each $1.0/MWh increase in variability. As such, there would have been a benefit in using two year instead of three year contracts, but the incremental benefit in going from two year to one year contracts would not have been as important.

Once again, it is important to mention that the hypothetical lower cost calculated by LEI for shorter contracts is mainly attributable to the decline in wholesale market prices.

On a forward looking basis, the Base Case and Low Price scenarios result in relatively small differences in cost and variability between FRS procurement through one, two or three year contracts. This outcome is consistent with the FRS suppliers anticipating the fundamental market driver trends and relying on the embedded risk premium to protect against weather-related price variations. In the Price Shock scenario, however, LEI assumed that supplier offers do not anticipate the changes in energy market prices for the 2018-19 and 2022-23 delivery periods. As such, the supply costs when relying on shorter contracts exhibit a lower average cost but higher variability, similar to the historical period analysis. In this scenario, two year contracts result in a $1.3/MWh decrease in costs for each $1.0/MWh increase in variability with respect to three year contracts. One year contracts result in a $2.1/MWh decrease in costs for each $1.0/MWh increase in variability with respect to three year contracts.

In addition to contract length, other parameters of FRS procurement, such as the block size, procurement period, or auction mechanism are discussed thoroughly in LEI's September 2015 Report. However, as shown through comparing the results of Delmarva's procurement auctions with neighboring jurisdictions, modifying these parameters is not expected to result in a major decline in expected supply costs or year-over-year variability of supply costs.

The overall takeaway from these simulations is that average costs from FRS procurement using shorter or longer term contracts will depend on the underlying trend in market prices and the predictability of such trends, as well as the timing of regulatory risk. In rising price conditions, longer term contracts will lag behind market prices and provide SOS customers with lower supply costs than shorter term contracts. Conversely, in declining price conditions, longer term contracts will provide SOS customers with higher supply costs than shorter term contracts.

Ultimately, therefore, the decision as to the length of the contracts must be made so as to balance the desire for FRS supply procurement costs to reflect market conditions, versus the desire for stable supply prices. Shorter contracts provide the former, while longer contracts provide the latter.

Changing the length of the FRS contracts for future procurement auctions would not require a major effort. Since current contracts must be honored, transitional contracts of different lengths would be necessary to transition from the three year laddering to the new FRS contract term until the existing FRS contracts expire.

The FRS supply procurement approach is transparent as auction documents are issued in advance describing the rules and requirements, all prospective suppliers are competing for the same product, and winners sign the same agreement. Furthermore, a single objective criterion is used to determine the winners, that criterion being the offered price. The full requirements approach is also used in other PJM jurisdictions, and as such, potential suppliers are familiar with it. These factors should encourage participation in the DPL SOS supply solicitations. Furthermore, an independent Technical Monitoring Consultant monitors the process to prevent potential harmful gaming behavior, such as tacit collusion or attempts to exercise market power.

In conclusion, if supply procurement through FRS contracts remains the primary method of securing supply for SOS load, modifying the length of the FRS contracts or any other parameter of FRS procurement would probably not result in a significant enough change in supply costs on average over the longer term. FRS contracts however remain a beneficial choice if part of a procurement portfolio, as is discussed further in the following sections.

5.4 Long-term contracts

For the SOS provider, entering into long-term contracts with suppliers offers certainty and stability in pricing as these contracts specify both the quantity and the price that the supplier is obligated to provide, assuming the contract price is not indexed to wholesale spot market prices.

A solicitation for long-term contracts should be efficient and transparent, and should ensure competition among potential bidders. At the same time, the process of developing a solicitation, preparing an agreement, and managing the contract can add costs to the SOS provider. However, given that Delmarva has the requisite experience with current FRS and renewable generation contracts, this may not be a significant issue.

While providing price stability, long term contracts may result in a discrepancy between the contracted price (which in turn will affect the SOS rates) and the PJM's wholesale electricity market prices for certain periods. This may hinder the development of a competitive retail market and could also violate Delaware's goal of least cost supply over a short period.

Long term contracts can arguably be advantageous for consumers if spot prices are expected to rise over the duration of the contract above the contract price. However, there is always a risk for both the buyer and seller in a long term contract arrangement, related to whether the contract will be priced lower or higher than realized spot market outcomes.

Another key advantage of long term contracts is that once in place, they can help generators finance their plant investments on favorable terms (compared to no long term contract), and those cost savings could be shared with consumers.

How can long-term contracts reduce the cost of financing capital investments

Large infrastructure assets such as those for electric generation usually require correspondingly large capital investments. Thus, a potential investor can ensure that enough revenues will be collected to pay for the investment by entering into forward contracts.

Increased price certainty and revenue stability through long-term contracts reduce risk for lenders and investors and results in a lower cost of capital for the project. A project's cost of capital is the rate of return required to compensate its investors at the same rate of return they would realize from available alternative investments of equivalent risk. With increased revenue stability for a project, investors require a lower return, which in turn reduces the cost of financing for the project, when compared with a project that relies purely on spot markets for revenues.

Furthermore, most projects are financed through a combination of debt and equity, so the cost of capital is a weighted-average cost of each. The degree of uncertainty surrounding a project's revenues can impact the amount of debt financing it can attract and the cost of attracting that debt financing. Projects with a greater uncertainty in revenues could be forced to use higher levels of equity and consequently face higher total financing costs. Generally, the riskier the investment, the less debt financing is available as a percentage of total capital.

For instance, a recent study[48] found that the cost of electricity from new renewable generation in New York State could be lower by $11-12/MWh with the use of Utility-Backed PPAs, as opposed to current REC-only contracts. While the study was performed with renewable generation in mind, the same economic principles apply to conventional generation as well.

However, care must be taken in selecting the right amount of contracted energy and capacity so as to achieve the desired level of supply cost hedging. As discussed earlier in Section 4.3, procurement of SOS supply through long-term contracts must be supplemented by another form of procurement, such as purchases from the spot market, to provide for load following. Furthermore, procuring too much energy and capacity through long term contracts can result in

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48 NYSERDA, *Large-Scale Renewable Energy Development in New York: Options and Assessment*, June 2015.

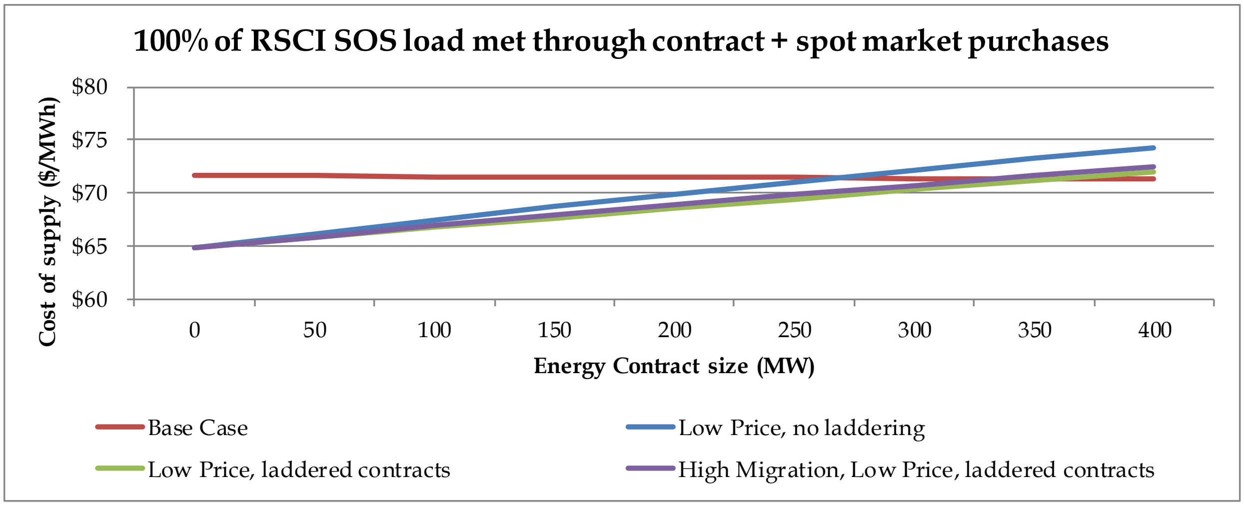
additional exposure to the spot market prices as some of the contracted quantities may need to be resold.

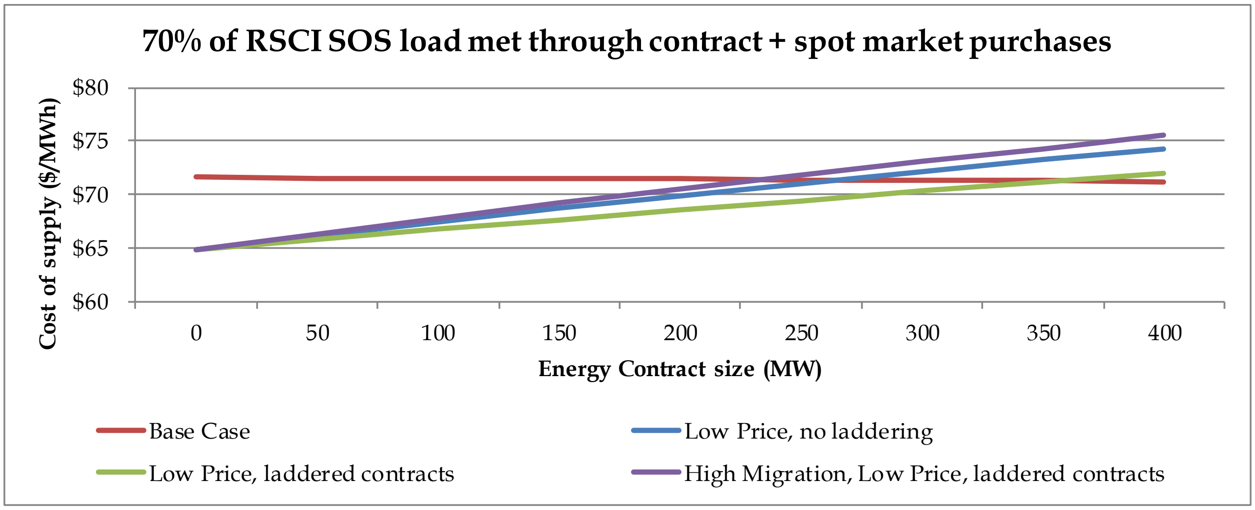
Figure 22 illustrates the average cost of SOS supply costs when procured through a combination of long term contracts and spot market purchases, for various pricing scenarios and contracted amounts. To simplify the display of these results, the horizontal axis represents the amount of contracted energy, with the assumption that contracts for capacity are secured in order to hedge the same percentage of the capacity requirement as is hedged through the energy contracts. For instance, as discussed in Appendix B (Section 8.3.1), a 200 MW contract for energy would represent 1,752 GWh or approximately 60% of the RSCI SOS load. Therefore, in order to hedge 60% of the RSCI SOS capacity requirement, around 600 MW of capacity should be procured through long term contracts in addition to the energy contracts.

The top graph of Figure 22 illustrates the cost of supply when 100% of the RSCI SOS load is procured through a combination of long term contracts and spot market purchases. In the Base Case pricing scenarios, since the contracted supply cost is similar to expected market prices, the contracted amount makes little difference on the overall cost of supply. As a result, the line representing the average supply costs is flat across all contracted quantities. In the Low Price scenario, however, the contracted supply is priced higher than the spot markets. As a result, a larger contracted supply results in a higher overall supply cost. This explains why the lines representing the average supply costs are increasing as a function of the contracted quantities for the Low Price (no laddering of contracts), Low Price (laddered contracts) and the High Migration, Low Price scenarios. In the Low Price scenario, laddering the contracts as described earlier in Section 4.3.2 results in a lower supply cost than no laddering, as illustrated by the green curve. With High Migration case, prices are even higher since the SOS load is much smaller.

The middle and lower graphs of Figure 22 represent cases where long term contracts and spot purchases are supplemented by another procurement method, such as FRS contracts. In the middle graph, long-term contracts and spot purchases are assumed to supply 70% of RSCI SOS load, with FRS contracts supplying 30% of load. In the lower graph, long-term contracts and spot purchases are assumed to supply 50% of RSCI SOS load, with FRS contracts supplying 50% of load. Similarly to the top graph, in the Base Case pricing scenario, the average cost of the combination of contracted supply and spot purchases does not vary with contract size. However, in the Low Price scenario, since the contracted supply and spot purchases only supply a portion of the load, the exposure to above-market contract prices for a given amount of contracted supply will be greater and supply costs will increase. In summary, the amount of contracted supply will influence the overall cost of SOS supply if market conditions diverge from the contracted price, and a higher amount of contracted can increase exposure and risk associated with load levels.

Figure 22. Average cost over forecast horizon for supply procured through combination of long-term contracts + spot purchases





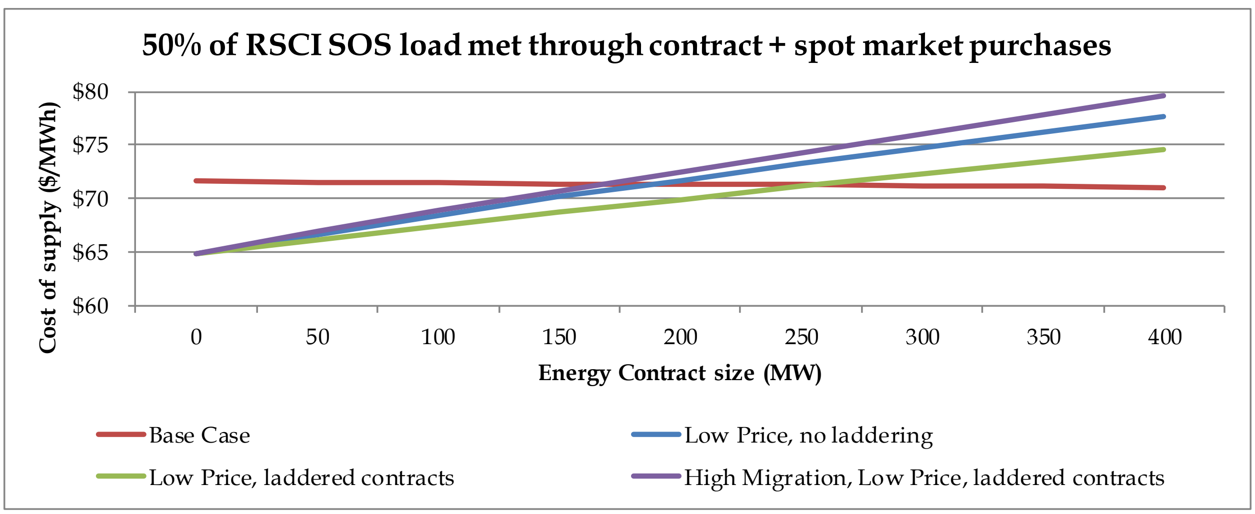


Figure 23. Average variability over forecast horizon for supply procured through long-term contracts + spot purchases

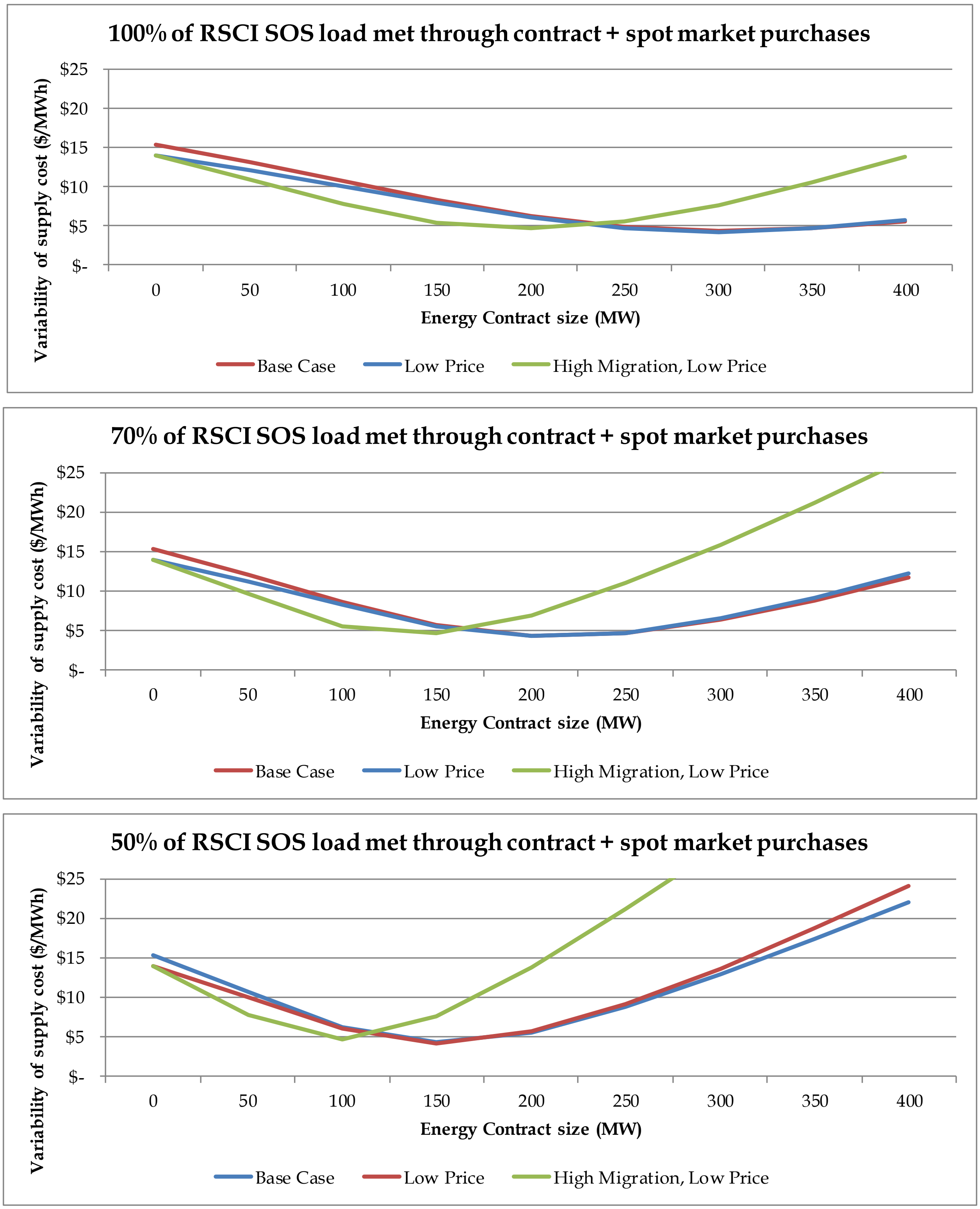


Figure 23 illustrates the average variability of SOS supply costs when procured through a combination of long term contracts and spot market purchases, for various contracted amounts. As previously, to simplify the display of these results, the horizontal axis represents the amount of contracted energy, with the assumption that contracts for capacity are secured in order to hedge the same percentage of the capacity requirement as is hedged through the energy contracts.

The top graph of Figure 23 illustrates the variability of supply when 100% of the RSCI SOS load is procured through long term contracts and spot market purchase. The middle and lower graphs represent cases where long term contracts and spot purchases are supplemented by another procurement method, such as FRS contracts. Variability is relatively similar in all scenarios using the IRP load forecast for RSCI SOS load, and initially declines the more contracted supply is procured. However, if too much contracted supply is procured, the need to sell excess supply in the spot markets will cause variability of supply costs to start increasing again. Thus, while the lines representing average supply costs in Figure are linear, the lines representing variability in Figure 23 are curved to illustrate the rising exposure to spot markets variability when excess supply is contracted. In the High Migration scenario, variability increases much more rapidly for larger contracted amounts since the SOS load is much smaller in that scenario. Therefore, in order to benefit from the low variability associated with long term contracts, the amount of contracted supply must be chosen so as to minimize the risk associated with excess supply, which must then be sold back in the spot markets.

Finally, if long term contracts are pursued, the SOS provider will need to issue a solicitation and follow a process similar to the current FRS procurement process. This process would include issuing a RFP and preparing a PPA. Administrative costs incurred by Delmarva (for example, for credit requirements under the contract and for managing the contract) would likely be similar to current costs of managing FRS or REC contracts.

In the RFP, the SOS provider could seek energy deliveries to the DPL zone, or alternatively to a widely traded hub such as the Western Hub. Similarly, capacity deliveries could be sought to the DPL zone or one of the parent PJM capacity zones, such as MAAC or RTO. The drawback of seeking deliveries outside of the DPL zone is that the SOS provider could be exposed to the energy and capacity price difference between the DPL zone and the delivery point. However, as a firm transmission customer, the SOS provider is entitled to ARRs. As such, the congestion risk in the energy markets can be mitigated through the nomination process so as to receive the proceeds from the Financial Transmission Rights ("FTR") auction on the nominated path. Alternatively, the ARRs can be converted into FTRs in order to hedge the congestion risk in the DA market on the selected paths.[49]

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[49] There is still a risk, however, that ARRs or self-scheduled FTRs would not cover the entire cost of congestion. PJM's external market monitor, Monitoring Analytics, found in the 2015 State of the Market report that "ARR and FTR revenues offset 42.1 percent of Day-Ahead Energy Market and the balancing energy market for the 2013 to 2014 planning period and 59.8 percent for the 2014 to 2015 planning period."

For capacity, there is no "congestion" hedging mechanism in the capacity markets. As such, a contract for capacity delivered to a zone other than DPL would be riskier.

A problem arises, however, when trying to compare offers delivered at different hubs. The evaluation would entail using a forecast of congestion and losses between the different delivery points. As such, from a transparency perspective, it would be better to seek all energy and capacity at the DPL zone, and offering ARRs equivalent to the contracted amount to those suppliers selected for energy deliveries. This approach is the same as is currently done with FRS procurement, where the winning suppliers are entitled to a share of Delmarva's ARRs equivalent to their share of the SOS load.

Consequently, the RFP could be structured so as to give potential suppliers of energy and capacity the option to specify a starting price and a rate of price increase throughout the contract term. Offers could then be compared by evaluating the Net Present Value ("NPV") of each offer using a predetermined discount rate.

The actual procurement of the suppliers could be performed using a reverse auction mechanism similar to that used for FRS contracts, if it can be adapted, since suppliers are familiar with it. Alternatively, a sealed-bid mechanism could be used. LEI's September 2015 Report has shown that both methods can result in competitive outcomes.

In conclusion, procurement of supply for a majority of the load through long term contracts (supplemented by purchases from the spot markets) would satisfy several of the evaluation criteria. For instance, a competitive solicitation for suppliers would be similar to implement as the current FRS procurement methodology, and can result in a transparent outcome. However, conversely to purchases from the spot markets, this approach would emphasize price stability to the detriment of consistency with the current market conditions, and the risks due to load variations would be borne by the SOS provider. Such an approach would not be in the best interest of RSCI SOS customers.

5.5 Supply procurement portfolios

As discussed in previous sections, each procurement method exhibits different characteristics in terms of cost and variability. There may therefore be benefits for the SOS provider in combining different percentages of supply procured from the individual procurement methods into a procurement portfolio.

As such, LEI compared the cost and variability associated with individual procurement methods and supply procurement portfolios combining certain percentages of the individual supply procurement methods. LEI performed the comparison for the historical 2007-08 to 2014-15 period and well as on a forward-looking basis, using all scenarios introduced in Section 3.1 to Section 3.5.

Figures in this section compare the average supply cost and variability of the previously defined alternative procurement methods, along with a number of procurement portfolios. The following table details each of the procurement methods or portfolios analyzed.

Purchases from the spot markets

SOS supply procurement is purchased from the spot markets, and the cost and variability are calculated, as described earlier in Section 4.1.

3 year FRS contracts

SOS supply is procured through three year FRS contracts, using a laddered approach as is currently in use in Delaware by the SOS provider.

50% of supply procured through 3 year FRS contracts, 50% of supply procured from the spot markets

This portfolio includes 50% of supply procured through 3 year FRS contracts with laddering, as is currently done, but the remainder of supply is procured through the spot markets. This portfolio would therefore provide a middle ground for the higher costs and lower variability associated with FRS with the lower cost but higher variability associated with purchases from the spot markets.

200MW contract + purchases from the spot markets

SOS supply is procured through 200 MW of energy contracts. As illustrated in Figure 34's top graph, a 200MW contract for energy represents approximately 60% of the RSCI SOS load over the contract horizon, and excess supply would represent less than 1% of the contracted quantity (using the 2014 IRP forecast). The energy contracts would be supplemented with 600 MW of capacity contracts. As illustrated in Figure 35's top graph, this quantity also represents approximately 60% of the RSCI SOS capacity requirement. LEI assumes that the 10 year energy and capacity contracts would be laddered, with half of the supply requirement procured every five years.

The remainder of the energy and capacity requirement would be procured through purchases from the spot markets, representing approximately 40% of the total supply.

30% of supply procured through 2 year FRS contracts, 140 MW contract for energy + purchases from the spot market

In this scenario, 30% of the RSCI supply requirement is procured through 2 year FRS contracts with laddering (i.e., 15% of supply requirement is procured annually using 2-year contracts). FRS contracts would be supplemented by a total of 140 MW in energy contracts (with 400 MW in capacity contracts), with the remaining supply procured through the spot markets.

Since FRS suppliers take on the risk associated with load levels, this portfolio would reduce the load risk with respect to a portfolio relying largely on contracts. Two year FRS contracts, as opposed to three years, would marginally increase variability but improve the consistency of FRS prices to the wholesale market prices. Furthermore, 140 MW of energy contracts and 400 MW of capacity contracts cover approximately 60% of the remaining load (or approximately 42% of total load). LEI assumes that the 10 year energy and capacity contracts would be laddered, with half of the supply requirement procured every five years.

Finally, spot market purchases would represent approximately 28% of the total supply purchases.

50% of supply procured through 2 year FRS contracts, 100 MW contract for energy + purchases from the spot market

In this scenario, 50% of the RSCI supply requirement is procured through 2 year FRS contracts with laddering (i.e., 25% of supply requirement is procured annually using 2-year contracts). FRS contracts would be supplemented by a total of 100 MW in energy contracts (with 300 MW in capacity contracts), with the remaining supply procured through the spot markets.

Even more so than the previous portfolio, this portfolio would reduce the risk associated with load variation with respect to a portfolio relying largely on contracts, since FRS suppliers take on the risk associated with load levels. Two year FRS contracts, as opposed to three years, would marginally increase variability but improve the consistency of FRS prices to the wholesale market prices. Furthermore, 100 MW of energy contracts and 300 MW of capacity contracts cover approximately 60% of the remaining load (or approximately 31% of total load). LEI assumes that the 10 year energy and capacity contracts would be laddered, with half of the supply requirement procured every five years.

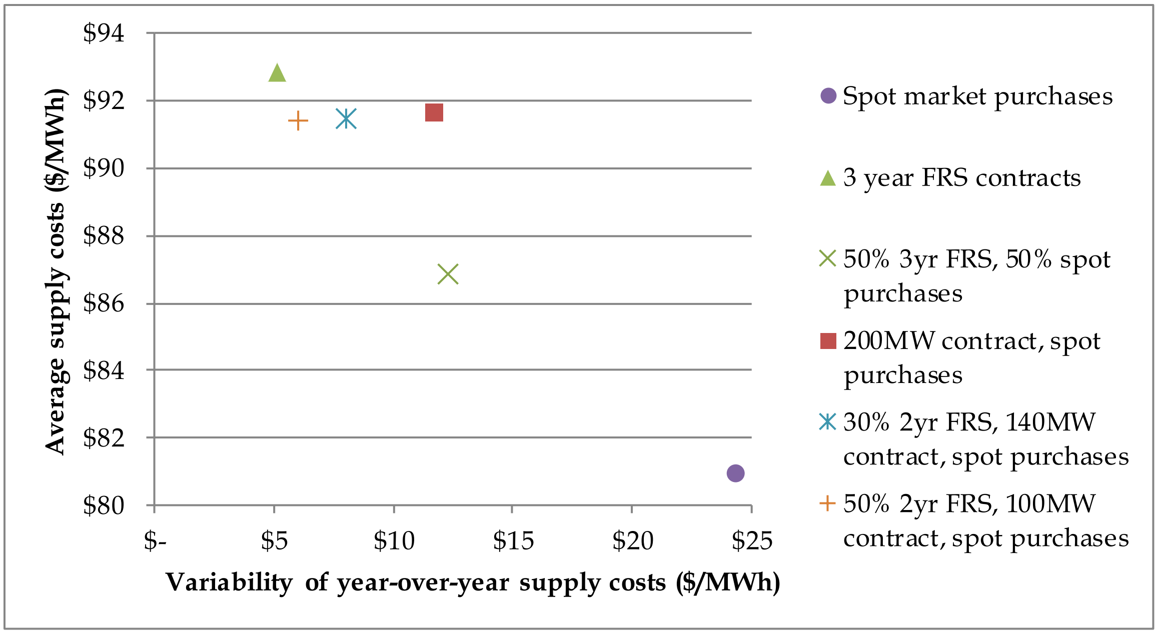
Finally, spot market purchases would represent approximately 19% of the total supply purchases.

Historical Scenario

Figure 24 illustrates graphically the relationship between the average cost of supply for a given procurement method or portfolio (on the vertical axis) and the average variability of supply cost (on the horizontal axis) for these same procurement methods or portfolios, using historical realized prices.

Historically, the average actual cost of SOS supply using three year FRS contracts has been $92.8/MWh, with a variability of $5.1/MWh. Spot market purchases, on the other hand, would have represented average costs of $80.8/MWh with a variability of $24.4/MWh. In addition to the risk premium (averaging $10/MWh) embedded in FRS supplier offer, the difference in cost can be attributed to the downward trend in power prices over the period, and the lag with which FRS prices follow market prices induced by the laddering approach. As such, SOS customers traded decrease in variability of $19.3/MWh for a supply cost premium of $12.0/MWh, which means that spot market purchases would have provided an average decrease in supply costs of $0.6/MWh for each $1/MWh increase in supply cost variability.

Figure 24. Comparison of cost vs variability for various procurement portfolios for historical period



Change in average cost of supply for each $1/MWh increase in variability with respect to procurement of three year FRS contracts		
Spot market purchases	$	(0.6)
50% 3yr FRS, 50% spot purchases	$	(0.8)
200MW contract, spot purchases	$	(0.2)
30% 2yr FRS, 140MW contract, spot purchases	$	(0.5)
50% 2yr FRS, 100MW contract, spot purchases	$	(1.7)

In between these two extremes, a hypothetical portfolio composed of 50% FRS contracts with 50% spot market purchases would have averaged the cost of these two procurement methods at $86.8/MWh, with a combined variability of $12.3/MWh. This portfolio would have resulted in savings for consumers with respect to the actual procurement costs, representing an average decrease in supply costs of $0.8/MWh for each $1/MWh increase in supply cost variability, which is slightly better that spot market purchases as discussed above. However, the variability of this portfolio, representing $12.3/MWh or 14% of the supply costs, is still significant.

For the historical period, contracting for 200 MW of energy and 600 MW of capacity under 10 year contracts such that around 60% of the RSCI SOS load is covered would have resulted in very little excess surplus contracted power. The remainder of the load would be served through purchases from the spot markets, representing approximately 40% of the RSCI SOS load. Because of the unexpected decline in wholesale market prices following the 2008-09 recession and the increased penetration of natural gas from shale regions, however, contracts signed in the 2006-07 timeframe would have reflected the expected trend in market conditions at the time, and not the actual decline in prices.

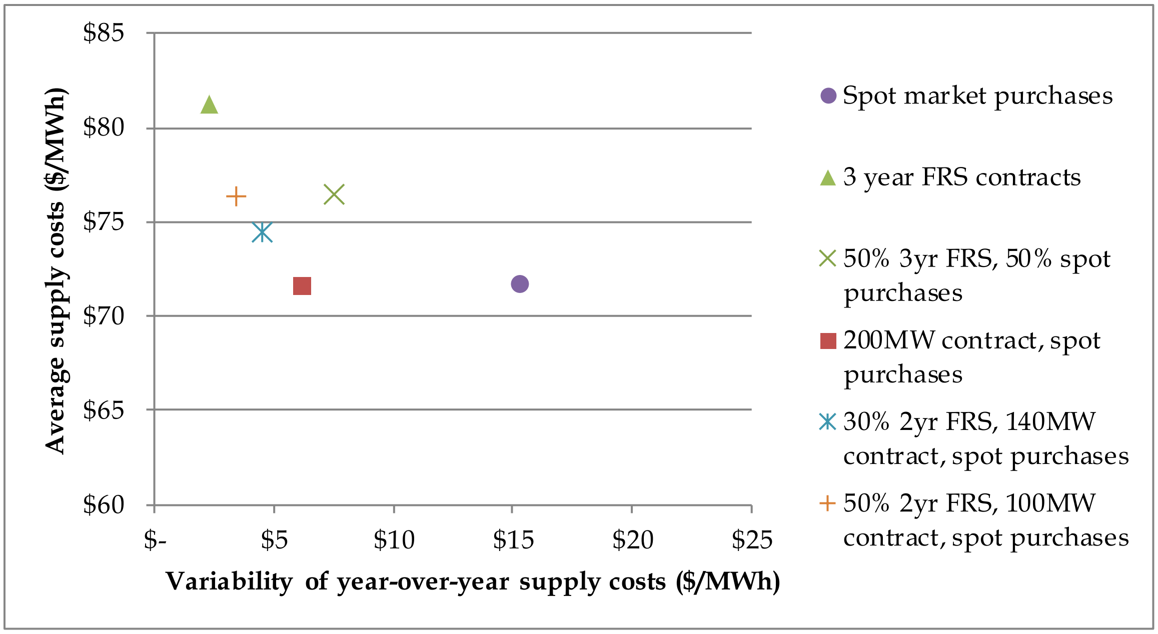
However, since contracted supply only represent a portion of the supply requirement, and the laddering of the long term contracts would have resulted in reduced contracted supply costs for the second half of the historical period, all three portfolios featuring long term contracts would have yielded supply costs which were, on average, slightly ($1/MWh to $2/MWh) below the actual FRS costs. Variability of these contracts, however, would have depended on the percentage of purchases from the spot market included in each portfolio, ranging from $6/MW (for the 50% 2yr FRS, 100 MW contract + spot purchases portfolio) to $12.0/MWh (for the 200 MW contract, spot purchases portfolio). The portfolio featuring a 200 MW energy contract would have resulted in a decrease in average cost of supply of $0.2/MWh per $1/MWh increase in supply variability, which is a lower ratio than procurement through the spot markets. The portfolios featuring 140 MW and 100 MW energy contracts would have resulted respectively in a decrease in average cost of supply of $0.5/MWh and $1.7/MWh per $1/MWh increase in supply cost variability, ratios which are respectively similar and better than purchases from the spot markets.

Base Case scenario

In the Base Case forward looking scenario, as illustrated in Figure 25, purchases from the spot market would yield supply costs averaging $71.6/MWh, with an average year-over-year variability in supply costs averaging $15.4/MWh. As FRS contracts are expected to command a premium over forward market prices, this method of procurement would yield an average cost of $81.2/MWh . Variability, however, would benefit from the laddering approach and fixed-price nature of the contracts, and as a result represent on average $2.3/MWh. As such, supply costs if purchased from the spot market would have decreased by $0.7/MWh for each $1/MWh increase in supply cost variability with respect to procurement of three year FRS contracts. This ratio is similar to the ratio calculated in the scenario using historical prices.

In the Base Case scenario, long term contracts pricing terms are expected to reflect wholesale market conditions. As such, the average costs for supply procured from the spot markets or under contracts are very similar, averaging $71.6/MWh over the horizon. Variability, however, is greatly reduced when purchasing most of the supply through long term contracts. In this scenario, variability is $15.4/MWh for supply purchased from the spot markets, but is reduced to $6.2/MWh if a 200 MW contract for energy is signed. As a result, if compared to the procurement of three year FRS contracts, this portfolio would have resulted in a decrease of $2.5/MWh in supply costs for each $1/MWh increase in supply cost variability. This ratio is much higher than the ratio of spot market purchases discussed above.

Figure 25. Comparison of cost vs variability for various procurement portfolios for Base Case forward-looking scenario



Change in average cost of supply for each $1/MWh increase in variability with respect to procurement of three year FRS contracts		
Spot market purchases	$	(0.7)
50% 3yr FRS, 50% spot purchases	$	(0.9)
200MW contract, spot purchases	$	(2.5)
30% 2yr FRS, 140MW contract, spot purchases	$	(3.2)
50% 2yr FRS, 100MW contract, spot purchases	$	(4.7)

Both portfolios including 50% of supply procured from FRS would be priced similarly at approximately $76.4/MWh. The portfolio including a 100 MW energy contract in addition to spot market purchases yields an average variability of $3.36/MWh, as opposed to $7.49/MWh for the portfolio relying solely on spot market purchases for the remainder of the supply requirement. As a result, the portfolio featuring a 100 MW energy contract would have resulted in a decrease in supply costs of $4.7/MWh for each $1/MWh increase in supply cost variability with respect to procurement of three year FRS contracts, while the portfolio featuring only a mix of FRS procurement and purchases from the spot markets would have resulted in a decrease in supply costs of $0.9/MWh.

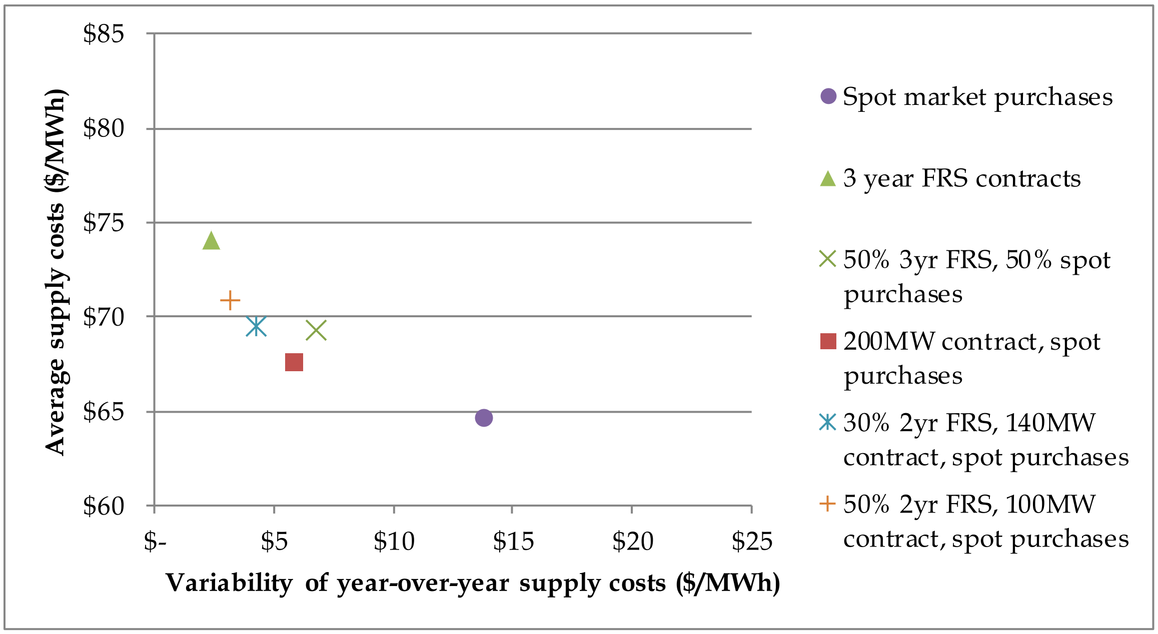
Finally, the portfolio including a 140 MW contracted energy supply, 30% for two year FRS contracts and spot market purchases would result in an average cost of $74.4/MWh with a variability of $4.5/MWh. This translates into a decrease in supply costs of $3.2/MWh for each

$1/MWh increase in supply cost variability with respect to procurement of three year FRS contracts, once again a much better ratio than for supply purchased through the spot markets.

Low Price scenario

In the Low Price forward looking scenario, as illustrated in Figure 26, the cost of supply if purchased from the spot markets is $64.5/MWh, approximately $7.1/MWh, or 10%, lower than in the Base Case scenario. Similarly, the cost of supply procured through 3 year FRS contracts would also reflect the lower wholesale market prices, albeit remaining approximately $9.54/MWh on average more expensive than supply from the spot markets. As such, supply costs if purchased from the spot market would have decreased by $0.8/MWh for each $1/MWh increase in supply cost variability with respect to procurement of three year FRS contracts.

Figure 26. Comparison of cost vs variability for various procurement portfolios for Low Price forward-looking scenario



Change in average cost of supply for each $1/MWh increase in variability with respect to procurement of three year FRS contracts		
Spot market purchases	$	(0.8)
50% 3yr FRS, 50% spot purchases	$	(1.1)
200MW contract, spot purchases	$	(1.9)
30% 2yr FRS, 140MW contract, spot purchases	$	(2.5)
50% 2yr FRS, 100MW contract, spot purchases	$	(4.3)

Pricing terms for long term contracts are expected to reflect wholesale market conditions expectations at the time the contracts are signed. As a result, realized prices which are lower than expected, such as illustrated in the Low Price scenario, would result in those early contracts being more expensive than wholesale market prices over time. As such, the average costs for supply procured from the spot markets in this scenario are approximately $3/MWh lower over the entire forecast horizon. The reasons for this relatively small difference are as follows:

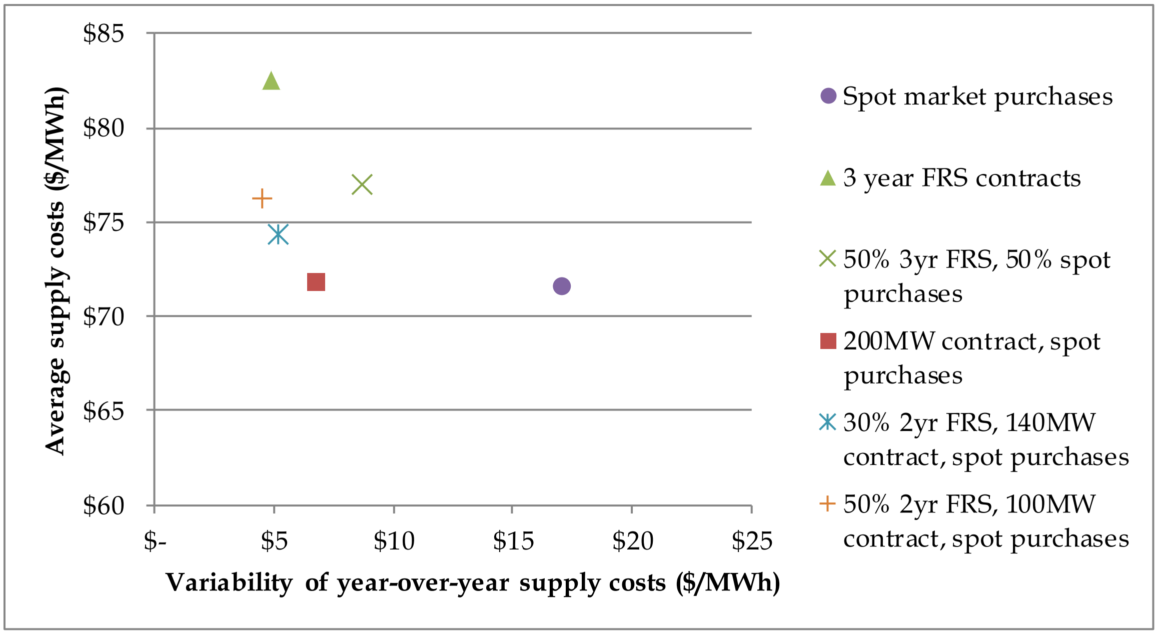
- early contract energy prices diverge from wholesale market prices over time, such that even if after 10 years there is a difference of $6.0/MWh, over the 10 year horizon, the difference is $4.4/MWh (on average);
- the laddered procurement of long term contracts would allow the contracted costs to be reduced after five years, when the new contracts would reflect the changed market conditions;
- contracted supply only represent a portion of the supply, with purchases from the spot market accounting for the remainder and as such keeping overall supply costs from increasing too much.

As in the Base Case, adding a percentage of supply procured from FRS to portfolios already including long term contracts and purchases from the spot markets would increase average cost, but reduce variability. This would also reduce risk associated with exposure to a fixed price contract, since smaller quantities of contracted supply would be required. For instance, procuring 30% of supply through FRS contracts, with a 140 MW energy contract and spot purchases, would reduce variability by $1.7/MWh with respect to 200 MW of energy contracts and no FRS procurement. Adding 50% of FRS procurement with a 100 MW of energy contracts would reduce variability by $2.7/MWh. Overall, the ratio of change in average cost of supply for each $1/MWh increase in variability with respect to procurement of three year FRS contracts is better for the portfolio featuring the smaller contracted supply as opposed to a larger quantity of contracted supply. All three portfolios featuring contracted supply have a better (higher) ratio than supply purchased only through the spot markets.

Price Shock scenario

In the Price Shock scenario, as illustrated in Figure 27, the focus is on the variability of the various procurement methods. In this scenario, the variability of FRS procurement is $4.9/MWh, still much lower than supply purchased from the spot markets, which exhibits a variability of $17.1/MWh. However, in this scenario, the portfolios integrating long term contracts would be less susceptible to these changes in market conditions as the contract prices are fixed. As a result, while the overall supply costs of portfolios are similar to the Base Case, the variability of portfolios including long term contracts and spot market purchases is much closer to the variability of an FRS only procurement method. In the Base Case, the variability of all three portfolios including long term contracts and spot market purchases was within $4.0/MWh of FRS-only procurement variability. In the Price Shock case, however, portfolios with including long term contracts and spot market purchases are all within $2.0/MWh of the FRS-only procurement method average variability.

Figure 27. Comparison of cost vs variability for various procurement portfolios for Price Shock forward-looking scenario

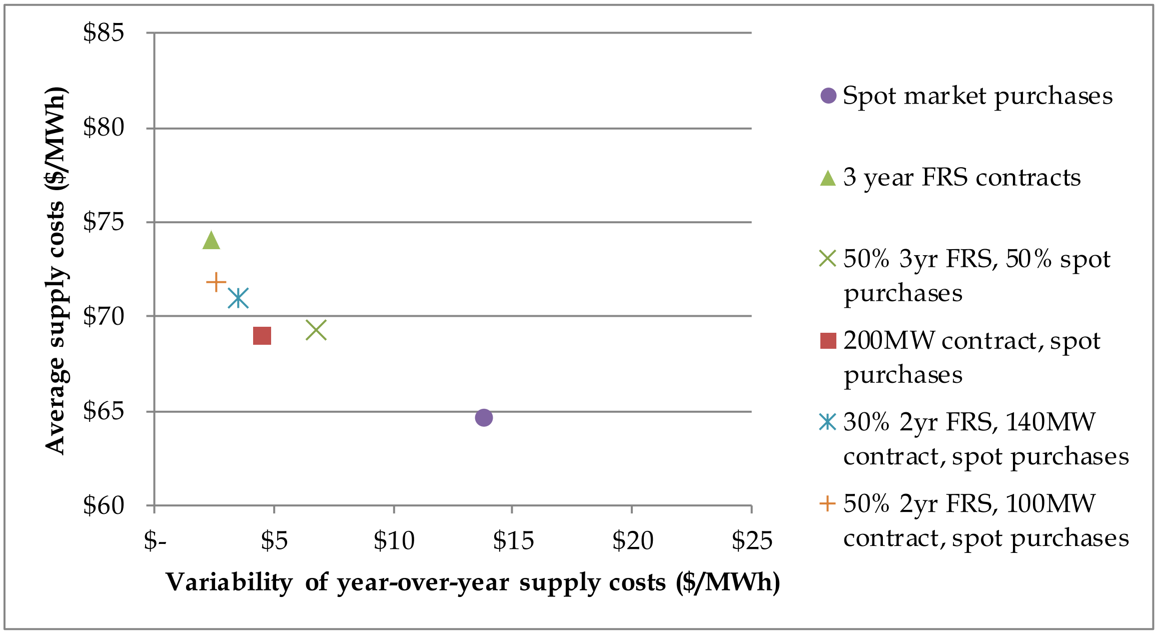


Change in average cost of supply for each $1/MWh increase in variability with respect to procurement of three year FRS contracts		
Spot market purchases	$	(0.9)
50% 3yr FRS, 50% spot purchases	$	(1.5)
200MW contract, spot purchases	$	(5.5)
30% 2yr FRS, 140MW contract, spot purchases	$	(30.2)
50% 2yr FRS, 100MW contract, spot purchases	N/A	

For instance, the portfolios featuring 100 MW and 140 MW energy contracts would result in a variability of supply costs similar to the procurement through three year FRS contracts. However, the average cost of supply would be lower than FRS procurement alone by $6.3/MWh and $8.2/MWh respectively, essentially providing customers with lower costs of supply with a very little increase in variability of supply costs with respect to FRS procurement alone. All three portfolios featuring long term contracts result in much higher ratios of change in average cost of supply (for each $1/MWh increase in variability, with respect to procurement of three year FRS contracts), relative to portfolios that do not rely on long term contracts for a portion of the supply requirement.

High Migration, Low Case scenario

Figure 28. Comparison of cost vs variability for various procurement portfolios for High Migration, Low Price forward-looking scenario



Change in average cost of supply for each $1/MWh increase in variability with respect to procurement of three year FRS contracts		
Spot market purchases	$	(0.8)
50% 3yr FRS, 50% spot purchases	$	(1.1)
200MW contract, spot purchases	$	(2.4)
30% 2yr FRS, 140MW contract, spot purchases	$	(2.9)
50% 2yr FRS, 100MW contract, spot purchases	$	(13.7)

In the High Migration, Low Price scenario, as illustrated in Figure 28, the focus is on the risk associated with variation of the RSCI load level over time. Since both FRS contracts and spot market purchases are relatively independent from load levels,[50] the fixed quantity contracted supply could result in a much larger percentage of load covered by the contracted supply than desired. This in turn could result in excess supply sold in the spot markets, and a greater exposure to higher contract prices should wholesale market conditions trend lower than the contracted prices over time. This scenario is illustrated in Figure 28, with average supply costs

[50] While technically the price of FRS contracts is independent from load levels, changes in the actual load might get reflected through higher risk premiums embedded in supplier's offers, resulting in higher FRS supply costs.

of procurement portfolio including long term contract higher than average costs of supply purchased through the spot markets by $4.4/MWh to $7.2/MWh. In contrast, these portfolios where more expensive than purchases from the spot markets by $2.9/MWh to $6.3/MWh in the Low Price scenario using the 2014 IRP RSCI SOS load forecast.

In this scenario, all three portfolios featuring long term contracts still result in positive ratios of decreased costs versus increased volatility with respect to procurement of three year FRS contracts. These ratios are slightly higher than the ratios for portfolios that do not rely on long term contracts for a portion of the supply requirement, which means that the proposed quantities of contracted supply would not represent a burden for consumers even in a conservative scenario such as the High Migration, Low Price scenario.

5.6 Summary

Figure 29 provides a summary of the average supply cost and volatility for the various procurement portfolios and scenarios.

Figure 29. Summary table of average supply cost and volatility for the various procurement portfolios and scenarios

All values in $/MWh	Historical scenario			Base Case scenario			Low Price scenario			Price Shock scenario			High Migration, Low Price scenario		
Portfolio	Cost	Variabi-lity	Ratio*	Cost	Variabi-lity	Ratio*	Cost	Variabi-lity	Ratio*	Cost	Variabi-lity	Ratio*	Cost	Variabi-lity	Ratio*
Spot market purchases	$80.8	$24.4	($0.6)	$71.6	$15.4	($0.7)	$64.5	$13.9	($0.8)	$71.5	$17.1	($0.9)	$64.5	$13.9	($0.8)
3 year FRS contracts	$92.8	$5.1	N/A	$81.2	$2.3	N/A	$74.1	$2.4	N/A	$82.5	$4.9	N/A	$74.1	$2.4	N/A
50% 3yr FRS, 50% spot purchases	$86.8	$12.3	($0.8)	$76.4	$7.5	($0.9)	$69.3	$6.7	($1.1)	$77.0	$8.6	($1.5)	$69.3	$6.7	($1.1)
200 MW contract, spot purchases	$91.6	$11.8	($0.2)	$71.5	$6.2	($2.5)	$67.5	$5.9	($1.9)	$71.7	$6.9	($5.5)	$68.9	$4.6	($2.4)
30% 2yr FRS, 140 MW contract, spot purchases	$91.5	$8.0	($0.5)	$74.4	$4.5	($3.2)	$69.5	$4.3	($2.5)	$74.4	$5.2	($30.2)	$71.0	$3.5	($2.9)
50% 2yr FRS, 100 MW contract, spot purchases	$91.4	$6.0	($1.7)	$76.4	$3.4	($4.7)	$70.8	$3.2	($4.3)	$76.3	$4.5	N/A	$71.8	$2.6	($13.7)

* The ratio value represent the change in average cost of supply for each $1/MWh increase in variability with respect to procurement of three year FRS contracts

In general, portfolios featuring a certain amount of contracted supply result in better ratios (larger decrease in supply costs per $1/MWh increase in variability) than portfolios that do not. The historical period provide an exception to that rule because of the declining power prices and LEI's conservative assumptions regarding the prices at which the SOS provider would have entered into long term contracts. However, despite these conservative assumptions, average cost over the historical period of these portfolios would not have surpassed the actual average cost of FRS procurement.

Among those portfolios analyzed by LEI and including a certain quantity of contracted supply, the portfolio featuring 100 MW of energy contracts resulted in the best ratio of decreased costs versus increased volatility across all scenarios. These results illustrate that a relatively small quantity of contracted supply can greatly benefit the overall supply portfolio. Increasing the amount of contracted supply further lowers the average expected cost of supply with respect to FRS procurement, although the overall ratio of decreased costs versus increased volatility is not necessarily as good as the portfolio featuring 100 MW of energy contracts. Additional modeling and testing may be necessary to refine the optimal risk-adjusted portfolio such that it provides lower expected average supply costs with an acceptable level of variability and price risk. Furthermore, with time, it might be reasonable to readjust the ratios of each procurement method within the portfolio so as to maintain an optimal balance of risk and cost of supply.

6 Recommendations

The Delaware PSC, in Order No. 8619 in Docket No. 14-0283 pertaining to LEI's review of Delmarva's current SOS supply procurement approach for RSCI customers, required LEI to recommend a procurement method and discuss "*whether such an approach will lead to lower energy supply costs over the long-term*". At the same time, PSC Staff and other stakeholders stressed the need to consider the stability of SOS supply costs. In addition, in crafting its recommendations, LEI has been mindful of the administrative costs associated with implementing a given SOS supply procurement approach.

Furthermore, in addition to lowering supply costs and minimizing the year-over-year variability of those supply costs, LEI's recommendations considered the four evaluation criteria introduced in Section 5.1, which are:

1. Efficiency and consistency with competitive markets;
2. Balancing benefits and costs to ensure the least cost to consumers ;
3. Consistency with overall Delaware policies; and
4. Ease of Implementation.

As a result, LEI set out to evaluate the expected costs of alternative procurement approaches and the variability of these costs under different market conditions. LEI examined alternative approaches, including purchases from the spot markets, purchases through long-term contracts, having the SOS provider build or purchase its own generation assets, or a combination if these approaches.

Early in the evaluation process, LEI concluded that further evaluation of the option of having the SOS provider build or purchase its own generation assets should not be recommended. The reasons for this decision include the relatively small size of RSCI SOS load when compared to the smallest practical size for CCGT generation resource, as well as the risks involved in owning and operating a power plant. The SOS provider would not benefit from economies of scale afforded to owners of large generation portfolios.

LEI's analysis of the current method of procuring supply for the RSCI SOS load (three year FRS contracts), together with the analysis of alternative methods of procuring supply, has shown that these alternative methods could result in lower average expected supply costs in the future, albeit with some tradeoffs in terms of the variability of these costs. While purchases from the spot markets would likely prove the least expensive procurement method, the variability of supply costs associated with the wholesale markets is very high when compared to other methods of supply procurement. Conversely, procuring a majority of the supply through long-term contracts could lead to a big deviation of SOS rates from actual market conditions. This would also lead the SOS supply costs to be more dependent on the contracted supply should the customer migration rate increase.

In order to improve upon these procurement hypotheses, LEI further evaluated potential supply portfolios, each combining a certain percentage of supply from various procurement methods. Combining FRS procurement and purchases from the spot markets would provide a tradeoff between the FRS contracts' low risks and price variability, and the expectation of lower prices from the wholesale markets. However, LEI's analysis has shown that long-term contracts can also provide benefits in terms of low prices and low volatility. As a result, LEI analyzed portfolios that include a certain percentage of supply procured through FRS contracts and long term contracts, with load following for the long term contracts provided by purchases in the spot markets.

LEI's analysis showed the merits of a portfolio approach, which can result in a lower cost of supply, with respect to the current FRS procurement method. Portfolios, however, will impact the variability of supply, as well as potentially increase the administrative requirements for the SOS provider. The composition of the portfolio can affect the ratio of decrease in supply costs with respect to increase in variability of costs. While LEI did not consider every possible combination, the analysis of alternative procurement methods suggested that a portfolio composed of 30% two year FRS contracts, in addition to contracted supply equivalent to approximately 60% of the remaining SOS load (or 42%[51] of the overall supply requirement),[52] with the remaining supply procured through spot market purchases, is potentially the most appropriate option among those combinations that were evaluated. Such a portfolio would result in lower expected costs of supply when compared to the current SOS procurement approach (i.e., FRS). The portfolio procurement method, however, would also result in a moderately higher variability of supply costs relative to FRS procurement, as well as increase the administrative requirements for the SOS provider.

Should the PSC decide to pursue a portfolio approach, additional modeling and testing may be necessary to refine the optimal risk-adjusted portfolio such that it provides lower expected average supply costs with an acceptable level of variability and price risk. Furthermore, with time, it may be reasonable to readjust the ratios of each procurement method within the portfolio so as to maintain an optimal balance of risk and cost of supply.

In the suggested portfolio, approximately 42% of the overall energy and capacity supply is procured through long term contracts. As a result, the remaining 58% procured through spot market purchases and FRS contracts will reduce the risk associated with load variations as the cost of supply through these procurement methods is generally independent from the actual load level.[53] Furthermore, the combination of FRS procurement and spot market purchases will ensure that the price for 58% of the supply follows the trends in market conditions. While

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[51] Considering FRS contracts accounts for 30% of supply, 60% of the remainder supply requirement corresponds to 42% of overall supply requirement (60% times 70%).

[52] Using the load forecast from Delmarva's 2014 IRP, the contracted quantities would correspond to 140 MW of around-the-clock energy contracts and 400 MW of capacity contracts.

[53] Although large and unexpected variations in the SOS customers migration rate could result in an increase of the risk premium embedded in FRS suppliers' offers.

supply costs associated with spot market purchases have high variability, the FRS contracts, while also reflecting market conditions, provide for a much more stable cost of supply. Overall, only 28% of supply is procured from the spot markets, so that 72% of supply provided through long term contracts and FRS contracts provide price stability in the portfolio, and protect the SOS provider from the regulatory risks associated with changes in market rules.

Historically, LEI's proposed procurement portfolio would have resulted in supply costs similar to the actual costs of FRS supply, with a slightly larger variability of $8.0/MWh as opposed to $5.1/MWh for FRS procurement. It is interesting to note that in what constitutes a very conservative scenario for long term contract costs, LEI's proposed portfolio would not have been more expensive than the actual procurement approach.

On a forward looking basis, LEI's proposed portfolio is expected to be approximately $6.8/MW less expensive than FRS procurement in the Base Case scenario. The tradeoff for this approach is an increase in variability by an average of $2.1/MWh. As such, LEI's recommended portfolio would yield an expected decrease of $3.2/MWh in average supply costs for each $1/MWh increase in variability. The proposed portfolio would similarly result in average supply costs with respect to FRS procurement in the other scenarios analyzed, albeit with a modestly higher variability in supply costs The increased variability could also allow SOS rates to follow more closely the wholesale market prices, thus facilitating the emergence of competitive retailers.

Regarding the procurement of FRS supply in LEI's proposed portfolio, LEI suggests that the SOS provider switch to two year contracts as opposed to the current three year contracts, with a laddered approach allowing for one half of the required FRS supply to be procured each year. This approach would allow for the FRS costs to follow the underlying power market conditions more closely, while also increasing the amount of load auctioned every year. Indeed, the current amount of PLC load auctioned every year is approximately 256 MW. Assuming that only 30% of SOS supply is procured through FRS contracts, the amount of PLC load auctioned every year would be approximately 77 MW if keeping the current approach of using three year laddered contracts.

This lower value might not be sufficient to entice participation from potential suppliers given the administrative requirements for qualifying in the auction. Using two year contracts, the amount of FRS load auctioned every year would represent approximately 115 MW. By further offering the entire annual supply requirement in the first tranche, keeping a potential second tranche in case of insufficient supply in the first tranche, and foregoing the third tranche, the amount of load offered at the auction event would be equivalent to the amount currently offered. As such, the SOS provider would plan a single auction event around early February (similar to the current second tranche FRS auction timeframe). This would be as close as possible to the start of the delivery period while allowing sufficient time for the winning suppliers to nominate the ARRs.

For the long term contract portion of the procurement portfolio, LEI recommends securing contracts equivalent to 60% of the load not covered through the FRS contracts.[54] Given the current load forecast from the 2014 IRP, this corresponds to 140 MW of contracted energy and 300 MW of contracted capacity over the 2016-2025 timeframe. LEI recommends that the SOS provider issue a solicitation for 10 year contracts, with half the required supply procured every five years so as to setup a laddered procurement approach.[55] LEI suggests that the same reverse-auction method be applied to procurement of long term energy and capacity contracts as is currently used for FRS procurement, where the potential suppliers would submit offers for blocks of energy and/or capacity (with possibly different suppliers for energy and capacity). Suppliers could offer a starting price value and rate of increase over the life of the contract, and the auction engine would use the NPV cost of the contract[56] as the metric to compare the offers.[57] All contracted energy and capacity supply would be deliverable to the DPL zone, with the winning suppliers of energy entitled to the corresponding value in ARRs. The procurement of long term contracts could possibly be held in conjunction with the procurement of FRS contracts, so as to minimize the administrative requirements for Delmarva and other suppliers who may be interested in placing bids for all products.

Finally, LEI recommends that the remainder of the supply requirement be purchased through the spot markets. With two year fixed-price FRS contracts and 10 year fixed price, fixed quantity contracts covering respectively 30% and 42% of the supply requirement, purchases from the spot market would represent approximately 28% of the total supply requirement.

LEI's proposed portfolio satisfies all of the evaluation criteria set forth to evaluate the alternative procurement portfolios. First, it represents a potential for lower supply costs when compared to the current SOS supply procurement method under the market conditions examined. While the expectation of lower supply costs come at the expense of increased variability of costs, that increase is modest. The portfolio approach also ensures mitigation of the load variation risk as well as the market price risk by not relying entirely on a particular procurement method susceptible to these risks.

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[54] If FRS contracts represent 30% of SOS supply requirement, and long term contracts represent 60% of the remaining load, then long term contracts represent approximately 42% of the overall supply requirement.

[55] In order to setup the laddering, the very first procurement event would need to offer five year contracts for half the load and 10 year contracts for the other half; after which all procurement events would offer 10 year contracts.

[56] The NPV cost of the contract would be calculated based on a previously identified and published value for the discount rate, presumable representing the average inflation forecast over the contract term.

[57] This is similar to the current process for FRS procurement, where potential suppliers offer different prices for summer and winter periods. The average annual value of the offer is calculated by the auction engine using predetermined load factors for summer and winter SOS energy.

By relying on the combination of spot market purchases and the procurement of two year FRS contracts for approximately 72%[58] of the supply requirement, the proposed portfolio ensures that the SOS prices will be consistent with the underlying wholesale market conditions. Furthermore, both the FRS and long term contracts can be procured through a similar auction mechanism, ensuring a competitive outcome for all products.

Furthermore, considering that the FRS and long term contracts can be purchased through a process similar to the current reverse-auction based procurement process, with which the SOS provider is familiar, the administrative burden would not increase significantly. Separately, if the SOS provider does not possess the resources to participate directly in the spot markets to procure the remainder of the supply requirement, a third party can be hired to provide such service.

If a portfolio supply procurement approach such as proposed by LEI is approved by the PSC, it would not require any legislative change since House Bill 6 provides significant flexibility as to the method of procuring supply for the SOS load. Adhering to predetermined ratios of supply procured through each method, the composition of the portfolio would be fixed, thereby minimizing the active portfolio management burden for the SOS provider. The SOS provider also would not need to acquire market analysis or trading resources as hedging of market prices would be provided through the procurement of FRS and long term contracts.

Adjusting the proposed ratios of supply procured through each method over time could ensure that the supply quantities procured will be adequate given the evolution of wholesale market conditions and the RSCI SOS load volume. As such, this would ensure that the proposed portfolio will procure reliable supply for RSCI SOS customers over the long term, while balancing the benefits and costs of striving for the least cost to consumers.

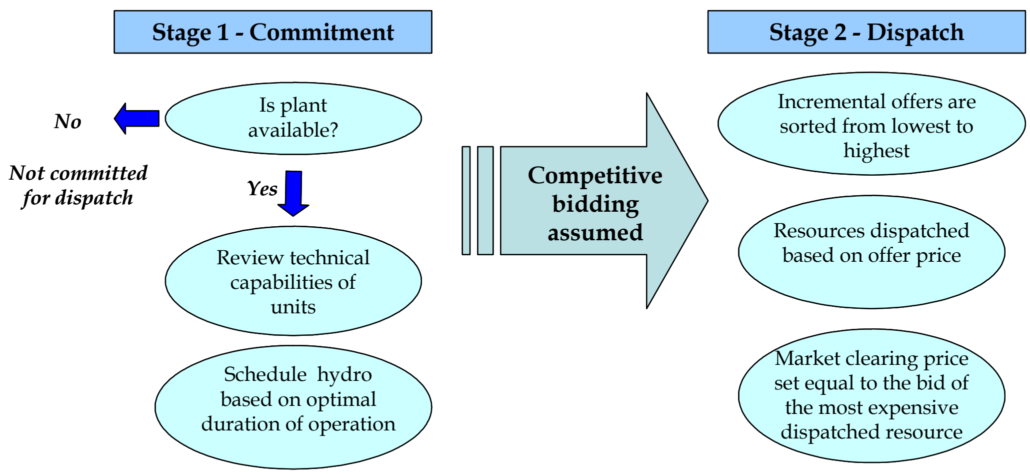
[58] 30% of overall supply through two year FRS contracts and 42% of overall supply through long term contracts.

7 Appendix A: Introduction to POOLMod

For the wholesale energy prices outlook, we employed our proprietary simulation model, POOLMod, as the foundation for our electricity price forecast. POOLMod simulates the dispatch of generating resources in the market subject to least cost dispatch principles to meet projected hourly load and technical assumptions on generation operating capacity and availability of transmission.

POOLMod consists of a number of key algorithms, such as maintenance scheduling, assignment of stochastic forced outages, hydro shadow pricing, commitment, and dispatch. The first stage of analysis requires the development of an availability schedule for system resources. First, POOLMod determines a 'near optimal' maintenance schedule on an annual basis, accounting for the need to preserve regional reserve margins across the year and a reasonable baseload, mid-merit, and peaking capacity mix. POOLMod then allocates forced (unplanned) outages randomly across the year based on the forced outage rate specified for each resource.

Figure 30. POOLMod's two-stage process



POOLMod next commits and dispatches plants on a daily basis. Commitment is based on the schedule of available plants net of maintenance, and takes the technical requirements of the units [such as start/stop capabilities, start costs (if any), and minimum on and off times] into consideration. During the commitment procedure, hydro resources are scheduled according to the optimal duration of operation in the scheduled day. They are then given a shadow price just below the commitment price of the resource that would otherwise operate at that same schedule (i.e., the resource they are displacing).

Moreover, POOLMod is a transportation-based model, giving it the ability to take into account thermal limits on the transmission network.

8 Appendix B: Cost and variability calculations

8.1 Spot market purchases

8.1.1 Supply cost

Calculating the cost of electricity supply purchased from the spot markets includes the cost of each of the components of supply, which include energy, capacity, ancillary services, and other ISO fees.

Energy

PJM calculates both day-ahead and real-time energy market Locational Marginal Prices ("LMP"). While the markets are designed so as to result in a convergence of prices between DA and RT, hourly and daily price differences between DA and RT energy markets fluctuate from positive to negative. For instance, for both 2013 and 2014, the difference between the average annual DA and RT price was below $1/MWh.[59] Furthermore, the overwhelming majority of load is bid into the DA market. In 2013 and 2014, on average, 97.1% of load was cleared in the DA market while the remainder cleared in the RT market.[60] As such, LEI used historical DA energy market clearing prices as the cost for energy purchased from the spot markets in the historical scenario. LEI's outlooks on energy prices in the various scenarios can also be considered as representing the DA market clearing prices.

In order to calculate energy supply costs, LEI considered both the hourly shape for market prices as well as the hourly RSCI SOS load profile. Since energy prices tend to be highest when load is highest, the cost of energy supply is the weighted average of the hourly load and hourly market clearing price, and will be higher than a straight, unweighted average of hourly prices. Figure 31 illustrates the typical hourly RSCI SOS customer load for a summer month, as compared to the average energy market DA clearing price for Delmarva's service area for the same period.

Since SOS supply providers are responsible for electrical losses, LEI further adjusts the costs of energy to account for the larger amount of energy the suppliers must provide in the wholesale markets in order to cover distribution losses.[61]

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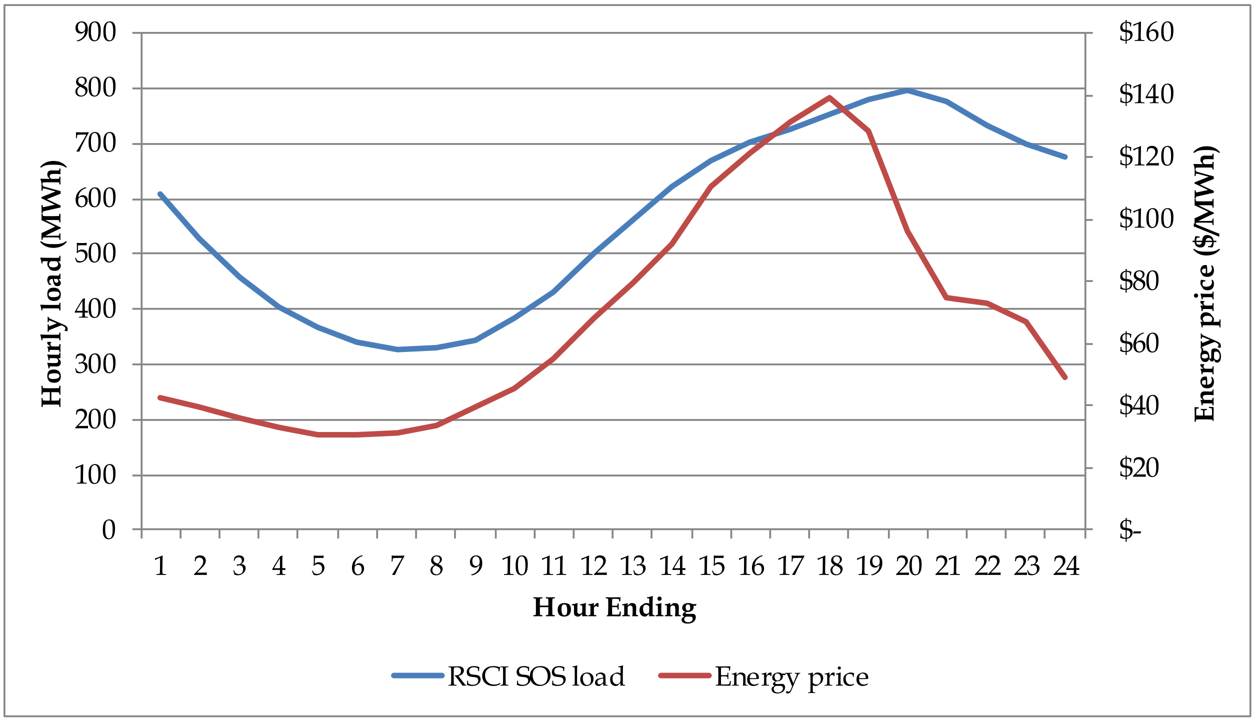
[59] Monitoring Analytics LLC, *State of the Market report for PJM*, page 70. March 12, 2015. <http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2014.shtml

[60] *Ibid*, page 88.

[61] LEI used Delmarva's RSCI energy loss factor of 1.07438.

Figure 31. Typical hourly profile for RSCI SOS load and DA market clearing prices



Sources: Delmarva, third party database

Capacity

For calculating the historical cost of capacity supply, LEI relied on data from past State of the Market reports from PJM's Market Monitoring Unit ("MMU"), which include a calculation of the average cost of capacity to load (in dollars per MW-day) for the various capacity zones.[62] On a forward basis, LEI used the capacity forecast associated with the scenarios previously defined in Section 3.1 through Section 3.5.

In order to convert the cost of capacity supply in dollars per MWh, LEI had to calculate a load factor for RSCI SOS customers, as illustrated in Figure 32. The load factor is necessary to relate the capacity requirement with the actual energy consumption, in order for capacity costs to be comparable to energy costs.

Using data from Delmarva's 2014 IRP, LEI calculated the average hourly energy usage for a year. LEI further calculated the capacity requirement as the forecast PLC in MW plus the

[62] Historical cost of capacity includes a weighted average of the BRA and incremental auction clearing prices, using the amount of capacity cleared for each respective auction.

anticipated reserve margin. The ratio of the two, representing the load factor for RSCI SOS customers, is approximately 37%.

Figure 32. Calculation of RSCI SOS load factor

year	Energy Forecast (GWh)	Average Energy usage (MW)	PLC (MW)	Reserve margin	Capacity requirement (MW)	Load factor
2016	2874	**328**	768.9	16.5%	**896**	**37%**

Sources: Delmarva, PJM

Ancillary services and other ISO fees

For calculating the cost of ancillary services and other ISO fees, LEI relied on data from past State of the Market reports from PJM's MMU which include a calculation of the average cost of ancillary services and other ISO fees to load. Ancillary services costs include synchronized and non-synchronized reserves, reactive power, regulation service, and black start. Other ISO fees include, among others, PJM administrative fees and Schedule 1A fees.

From 2001 to 2014, these costs have represented, on average, $2.4/MWh, or 5.8% of average energy prices.[63] From this data, LEI postulated that the cost of ancillary services and other ISO fees would remain a steady percentage of energy prices in the future and as such considered, for each forward-looking scenario, that annual ancillary service costs would represent 5.8% of the annual energy price.

8.1.2 Supply cost variability

For historical prices, the variability of purchases from the spot market can be assessed by calculating the standard deviation, in dollars per MWh, of historical variations in year-over-year total supply costs.

The forward-looking outlooks, however, are based on anticipated fundamental market drivers and regulatory changes and as such tend to represent a trend for energy and capacity prices. However, such unplanned events as mild/extreme weather conditions or equipment outages can cause actual annual energy prices to be above or below the predicted trend, thus affecting the variability of costs but not necessarily the average cost over the forecast horizon.

[63] LEI derived these figures using tables 1-9 from both the 2014 and 2012 State of the Market report, available at <http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2014.shtml>

LEI used historical wholesale market energy prices and historical forward prices to separate the variability due to fundamental changes, and variability due to weather or outages. LEI assumed that the average of calendar year forward energy prices for the month of October preceding a calendar year were representative of the anticipated energy prices when fundamental market drivers are considered.[64] LEI further assumed that the difference between the average annual realized energy price and the average of the preceding October's calendar year forwards represented the variability due to unplanned events.

For each of the pricing scenarios discussed in Sections 3.1 to 3.4, LEI combined the year-over-year variability of electricity costs due to fundamental market drivers (calculated directly from the outlook) with the historical variability calculated as described in the previous paragraph, so as to infer a global variability figure for each outlook.

8.2 Full Requirements Service

8.2.1 Product characteristics

FRS is the procurement method currently used by the SOS provider in Delaware to procure electricity supply through annual solicitations (each annual solicitation features two auctions). FRS in Delaware is a fixed price bundled product which includes energy, capacity, ancillary services and other ISO fees.[65] Since FRS obligation quantities represent a specific percentage of customer load, the supplier not only bears the risk associated with electricity costs but also with load variations. As such, the cost of FRS supply to SOS customers not only includes the cost for electricity supply as forecast at the time the auctions are held, but also a premium to cover the supplier's risks which is embedded in the supply offer.

Currently, Delmarva is procuring annually an amount of FRS supply equivalent to a third of its RSCI SOS load, with contracts having a term of three years. The length of the contract has bearing on the risk factors considered by the supplier when preparing a fixed price FRS offer. On the one hand, longer contracts could translate into greater load and price risk for the supplier. On the other hand, however, longer contracts mean that the offer would not be as dependent on weather because the average weather conditions over a longer period are less volatile than conditions for a single year.

In order to estimate the risk premium embedded in the FRS supply, and considering the opportunity cost for FRS suppliers is to sell into the wholesale markets, LEI compared past auction results[66] with the average anticipated cost of electricity from the spot markets at the

[64] LEI picked October forwards as the dates are reasonably close to the delivery year so as to accurately represent market drivers, but not so close as to start incorporating expectations of winter weather or fuel prices, which can greatly affect electricity prices

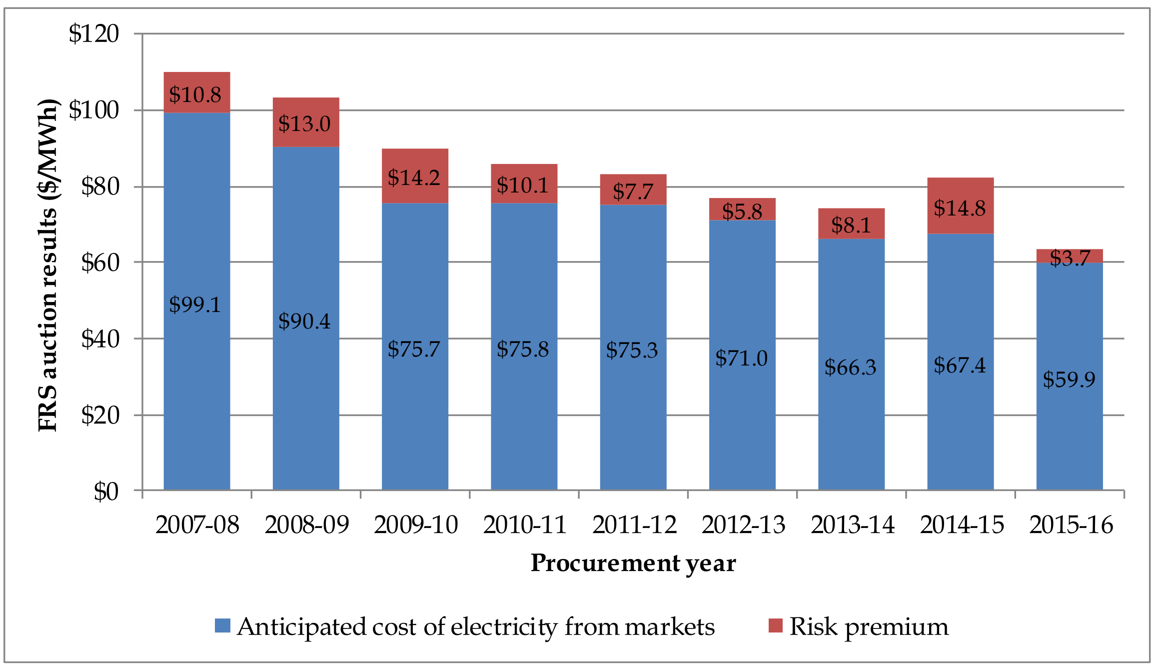
[65] Characteristics of the FRS product are discussed in depth in LEI's September 2015 report

[66] Past auction results are available on the Delaware PSC's website at <http://depsc.delaware.gov/sos.shtml>

time the auctions were held. The methodology for calculating the anticipated cost of electricity from the spot markets is similar to the methodology described in Section 8.1.1, with the exception that LEI used energy price forwards at the time the auctions were held, instead of the actual realized prices. For capacity, since the auctions are held on a forward basis, actual capacity prices are known at the time the auctions are held. Ancillary costs can be anticipated, but are relatively low compared to other FRS components.

Figure 33 illustrates the calculation of the historical risk premium, as the difference between actual annual procurement auction results and the anticipated cost of electricity supply, at the time the auctions were held, if purchased from the wholesale markets.

Figure 33. Breakdown by cost of electricity and risk premium for historical FRS auction results



Sources: Monitoring consultant auction reports, SNL, LEI

On average, for past FRS auctions, the risk premium embedded in supplier offers has been $9.8/MWh. It is interesting to note that the risk premium for the 2014-15 procurement auctions, at $14.8/MWh, was higher than average. These results can be explained by the uncertainty surrounding the introduction of the Capacity Performance product in the capacity markets, and the resulting low participation in the auctions. In contrast, results from the 2015-16 procurement proved particularly competitive, culminating with an estimated risk premium of $3.7/MWh.

8.2.2 Supply cost

For historical periods, the costs of FRS supply can be calculated from past auction results. Since supply procured in a procurement event represents one third of Delmarva's RSCI SOS load, the average cost of supply for a specific delivery period corresponds to the average of results from the previous three procurement events.

Similarly, using forward prices for each of the pricing scenarios as described in Sections 3.2 to 3.4, LEI calculated a forward cost of supply if it was purchased through FRS contracts. Although the costs of purchasing supply from FRS contracts are expressed in dollars per MWh, the actual migration rate may affect the risk premium embedded in suppliers' offers as the load risk would increase. As a result, the risk premium observed in historical FRS offers can be considered as a lower bound and could be higher should the migration rate become volatile.

Since LEI's outlooks are similar to forwards in that they anticipate future market conditions, they can be reasonably used as proxies to FRS component costs (energy, capacity, ancillary services, and other ISO fees) on which potential FRS suppliers would base their offers. The one exception is the price shock scenario, where LEI assumed that the market would not anticipate the large price differences for the 2018-19 and 2022-23 delivery periods, and the supplier offers would assume a growth rate in market prices similar to the growth rate of prior years.

8.2.3 Supply cost variability

As defined previously, the variability of FRS supply costs corresponds to the standard deviation of year-over-year changes in supply costs, expressed in dollars per MWh.

For historical periods, LEI calculated the variability of FRS supply costs using the actual supply costs, which for a given delivery year correspond to the average of the three previous procurement events because of the laddering approach. LEI further calculated the variability of supply costs from hypothetical two and one year FRS contracts, using the supply costs for each method as calculated in the previous section.

For the forward-looking scenarios, LEI calculated the variability of supply costs when procured from FRS contracts as the standard deviation of the year-over-year supply cost for each contract term option under the various pricing scenarios.

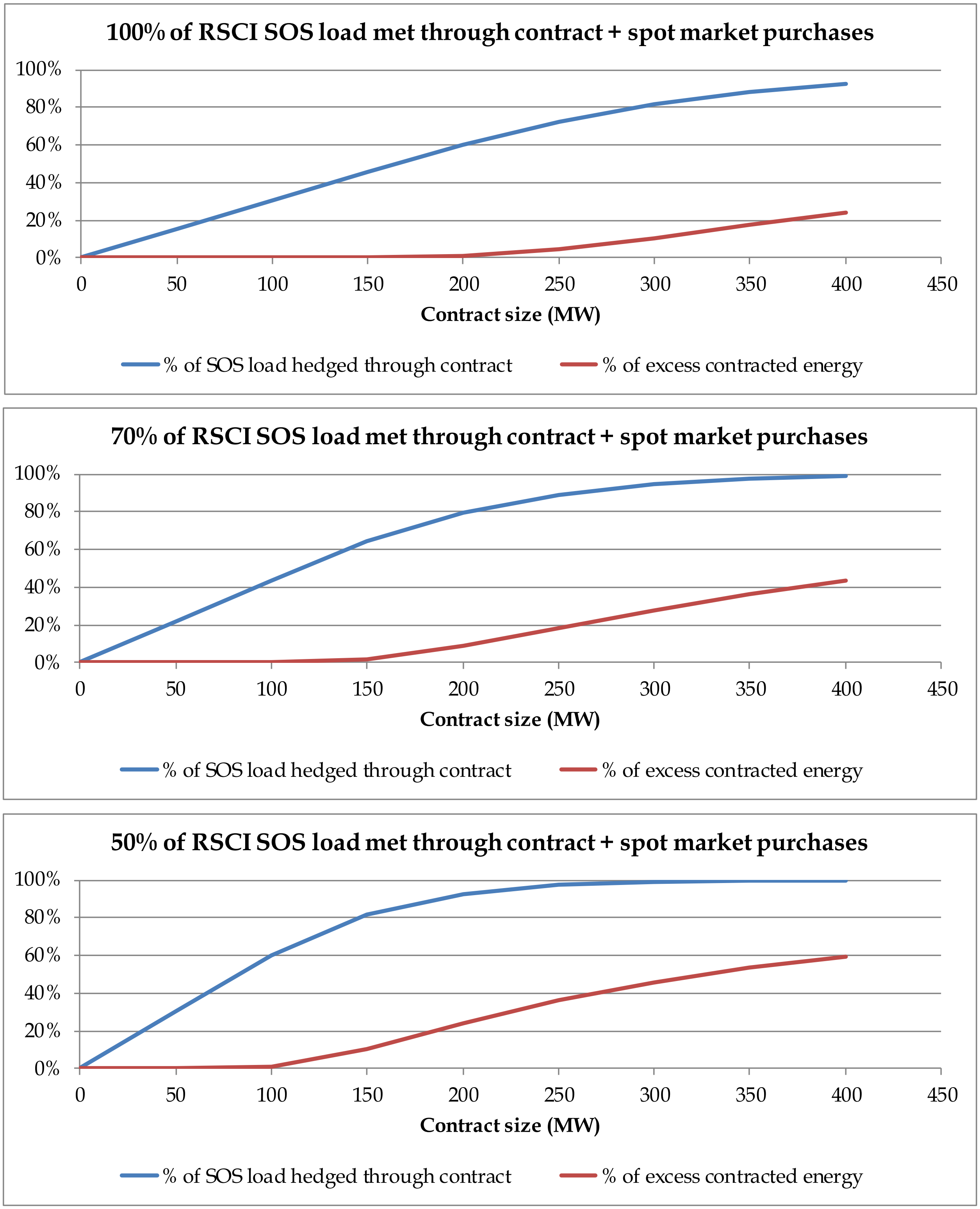
8.3 Long term contracts

8.3.1 Product characteristics

Figure 34 illustrates the energy hedging factor of various contract sizes under different procurement scenarios, using the load forecast from the 2014 IRP for the 2020-21 period (midway through the forecast horizon).

If 100% of the RSCI SOS supply requirement is met through a long-term energy contract supplemented by spot market purchases, a contracted amount of 200 MW will provide price hedging for approximately 60% of the load, with little risk of the contracted amount exceeding the load at any time. By contrast, a contracted amount of 350 MW will result in price hedging for 88% of the load, but 17% of the contracted energy will need to be resold in the spot markets.

Figure 34. Illustration of energy price hedging using long term contracts for 2020-21 period



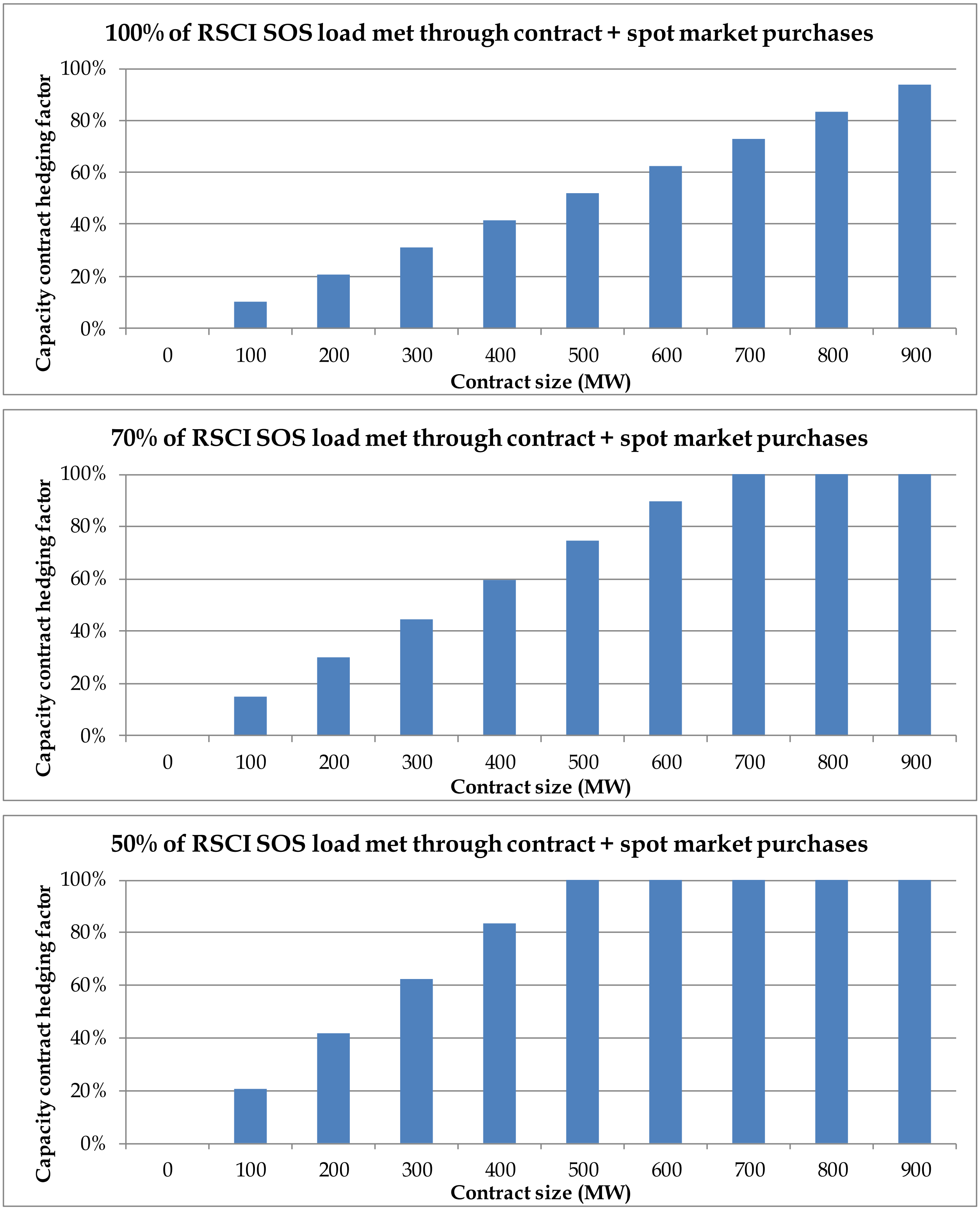
When the long term contract and spot market purchases are part of a supply procurement portfolio, for instance including FRS supply, the portion of load served by the contract is reduced. For instance, assuming 30% of the supply is procured through an alternative means such as FRS contracts, the long term contract and associated spot purchases will serve only 70% of the RSCI SOS load. In that scenario, a contracted amount of 150 MW will result in 64% of load being hedged, once again with little risk that contracted energy will need to be resold in the spot markets. If 50% of the supply requirement is met through alternative means, a contracted amount of 100 MW will result in 60% of load being hedged and little exposure to the spot markets will be left for excess contracted energy.

An LSE's capacity requirement is much larger than the energy requirement, since the installed capacity requirement represents the PLC of RSCI SOS load plus PJM's installed capacity requirement, as illustrated earlier in Figure 32.[67] As a result, a contract for energy and capacity designed to hedge a certain percentage of the energy cost will also result in capacity cost hedging, but for a much smaller percentage.

Figure 35 illustrates the hedging factor for various capacity contract sizes for the 2020-21 period. For capacity, a 200 MW contract would result in about 20% of the capacity requirement being hedged, whereas that same contract hedged a much higher percentage of the RSCI SOS energy supply requirement as discussed above.

[67] As PJM relies on a sloped demand curve in the BRA, the actual amount of capacity purchased can end up being slightly smaller or larger than the capacity requirement

Figure 35. Illustration of capacity price hedging using long term contracts for 2020-21 period



8.3.2 Supply cost

As discussed in the previous section, LEI assumed contract terms such that the energy and/or capacity prices may rise at an agreed-upon rate throughout the term, but are not indexed to market prices.

For the historical periods, LEI assessed expected market conditions around the 2006 timeframe, and again around the 2011 timeframe. These periods correspond respectively to the beginning of SOS supply procurement, and five year in the future (assuming laddered procurement of long-term contracts). LEI then studied two contract procurement hypotheses:

1. The decision was made to procure the desired contracted quantity in its entirety in the 2006 timeframe, at prices consistent with market expectations at the time, for a 10 year horizon;
2. The decision was made to ladder the procurement of contracted quantities (the equivalent of laddering), by purchasing half of the desired contracted quantity in 2006 and the other half in 2011.[68]

In order to calculate a hypothetical contract price around the 2006 timeframe, LEI analyzed power market forward prices and projections for fuel prices from the EIA AEO at the time. LEI found that using market prices expectations from the 2006-07 timeframe for the 2007-08 delivery period, with a 2% increase per year thereafter, provided a reasonable approximation of anticipated market conditions over a 10 year horizon. Since the contracts would be providing fixed amounts of energy and/or capacity, LEI assumed that the SOS provider would procure the ancillary services from the spot markets and pay the required ISO fees. Since these amounts are relatively small, the risk associated with these costs is low. LEI then used a similar methodology to calculate a hypothetical contract price around the 2011 timeframe, albeit using a 2.5% inflation factor to reflect the market expectations at the time.

Looking ahead, LEI assumed that energy and capacity prices for long term contracts are consistent with energy and capacity market expectations at the time the contracts are signed. Specifically, LEI assumed that the net present value of the contracted price over the contract horizon is equivalent to the net present value for wholesale market prices over the same horizon, using a 2% inflation rate.

LEI's Base Case scenario corresponds to the current market expectations for energy and capacity prices. As such, any contract signed in the near future would have pricing terms that reflect such expectations, irrespective of the actual realized prices. Similarly, any contract signed five years in the future would reflect the market expectations at that time. In that context,

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[68] In this scenario, in order to establish the staggering, it would have been necessary to procure the second half of contracted supply in 2006 for a duration of five years; thereafter, half of the contracted supply would be procured each five years for a duration of 10 years.

should the actual 2016-2020 market trajectory be consistent with the Low Price or the Price Shock scenario, the contracts signed 5 years in the future would reflect the modified expectations for market prices.

8.3.3 Supply cost variability

As explained in the previous section, long-term contracts are assumed to be fixed-price, where price steadily increases throughout the length of the contract. As such, this supply procurement method does not exhibit any variability.

8.4 Supply procurement portfolios

8.4.1 Supply cost

To assess the average cost of supply from a combination of supply procurement methods, LEI calculated the average supply costs for a given portfolio as the weighted average of costs for each procurement method in the portfolio. For instance, the average cost of supply for a procurement portfolio composed of 50% electricity purchased from FRS contracts and 50% procured from spot market purchases would be the average of cost of supply for these two methods.

8.4.2 Supply cost variability

In portfolio theory, the overall variability of a supply procurement portfolio is a function of the variability of the portfolio components, as well as the measure of how much the average annual cost of supply for different procurement methods change together.

Specifically, LEI calculated the variance of each procurement method. Each method's variability is defined as the standard deviation of year-over-year supply costs; the variance is calculated as the square of the standard deviation. LEI further calculated the covariance matrix between different procurement methods, which is the measure of how much the year-over-year costs of supply for different procurement methods change together. LEI calculated the covariance values from historical data.

Finally, LEI calculated the portfolio variance by multiplying the squared weight of each procurement method in the portfolio by its corresponding variance and adding two times the weighted average weight multiplied by the covariance of all individual procurement method pairs.

For instance, the following formula illustrates the portfolio variance calculation for a combination of two procurement methods:

$$Portfolio\ Variance = w_A^2 * \sigma 2 \quad (R_A) + w_B^2 * \sigma^2(R_B) + 2 * w_A * w_B * Cov(R_A, R_B)$$

Where w_A and w_B are the portfolio weights of procurement methods R_A and R_B; $\sigma^2(R_A)$ and $\sigma^2(R_B)$ are the variance values of procurement methods R_A and R_B; and $Cov(R_A,R_B)$ is the covariance value of procurement methods R_A and R_B.

Finally, the portfolio variability or standard deviation of year-over-year supply costs, is calculated as the square root of the average portfolio variance.