

# Backgrounder on Generation Capacity Markets

## EXECUTIVE SUMMARY

- Capacity markets have the potential to reduce the cost of providing electricity generation capacity by creating competition among generators and also between different supply technologies. However, the success of these markets depends crucially on a variety of design factors.
- The experiences of other jurisdictions with capacity markets suggest that capacity can be acquired from a range of supply technologies through a forward capacity auction at costs well below typical engineering and economic estimates of the full cost of new generation entry.
- Reform of capacity procurement in Ontario should be considered within the broader context of the electricity system since the ability of generators to recover fixed costs depends on well-functioning wholesale energy, capacity, and ancillary service markets operating in concert, as well as on operational and governance issues.

## INTRODUCTION

Generation capacity markets have the potential to more efficiently procure future generation for Ontario's electricity market. Cost savings in a capacity market are achieved in two ways. First, competition between generators lowers the cost of procuring capacity through competitive bidding pressures. Second, entry and technology risks are borne by investors and generators instead of by consumers and taxpayers.

Capacity is the availability to generate energy. From the perspective of electricity market design this is separate from energy, which is the physical provision of electricity to the grid. Since demand for electricity fluctuates over the course of a day and across seasons, it is important to have sufficient capacity at all times to ensure reliable power supply. This implies that a significant fraction of generating capacity exists to provide energy for only a small fraction of the hours in a given year (peak demand/load) or only to stand in reserve for contingency purposes (reserve margin).

In traditional regulated utility markets the cost of these resources are recouped at fixed rates. In theory, a perfectly competitive electricity market should be able to incentivize sufficient investment to provide adequate capacity. However, market failures or attributes of the market design can lead to under investment, and incentivizing investment in large infrastructure projects has historically proved to be difficult in deregulated markets.

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Promoting sufficient investment in generation to cover both peak load and reserve margin needs has often been achieved through either long-term contracts or centralized capacity markets.

A capacity market for electricity generation provides a way to competitively procure capacity in a future period through a forward auction or other mechanisms. This is in contrast to the current method of procuring capacity in Ontario through the use of long-term contracts and centralized procurement. While long-term contracts are successful in attracting investment, they have less flexibility to adapt to changing market conditions and place investment risk on customers. These are the specific weaknesses that centralized capacity markets are designed to address.

This Policy Brief serves as a backgrounder to generation capacity markets, beginning in the next section with a description of key attributes and functioning of capacity markets. It then provides a discussion of the anticipated financial benefits of implementing a capacity market in Ontario as well as an overview of the experience of capacity markets in other jurisdictions. Finally, some important caveats and key messages are discussed in considering the implementation of a capacity market in Ontario.

### ATTRIBUTES OF CAPACITY MARKETS

In a capacity market, generation capacity is typically procured through a flexible, competitive auction process. Firms bid to supply capacity during a specified period when and if needed, subject to non-performance penalties. Suppliers can be broadly defined in capacity markets, including customers who agree to reduce power consumption when requested (demand response), energy efficiency measures, or energy storage. In contrast to confidential private bilateral contracts, the transparency of an auction creates price signals for the electricity market and consumers. The auction design can also be flexible, allowing adjustments to be made to the length of the commitment period and mix of supply technologies.

The ability of a capacity market to incentivize adequate supply resources at low cost depends crucially on a set of market elements. These include 1) the shape of the demand curve, 2) the duration of the forward and commitment periods, 3) the definition of the capacity product, and 4) performance requirements.<sup>1</sup> Each of these attributes and their importance in the functioning of a capacity market are discussed briefly below.

***Demand Curve.*** To determine the amount of capacity to procure, system administrators construct a demand curve for electricity by approximating customer demand for capacity and the prices they are willing to pay. These demand curves are either modelled as vertical or downward-sloping. The shape of the demand curve affects price stability, price signals for new investment, and the amount of capacity procured. Vertical demand curves can lead to price volatility with prices potentially near zero when there is excess supply and at the maximum allowed when there is insufficient supply. This volatility occurs because the quantity procured does not vary with price and thus can be related to capacity additions, which are often larger than current shortfalls to account for future generation needs. Consequently, prices may drop significantly when new generation becomes available. [Figure 1](#) illustrates this “lumpiness” problem, which can be a disincentive to efficient investment in capacity that is moderated by

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<sup>1</sup> Measures to mitigate market power are also important in the design of capacity markets.

Figure 1: Increase in Supply of Capacity with Vertical Demand Curve

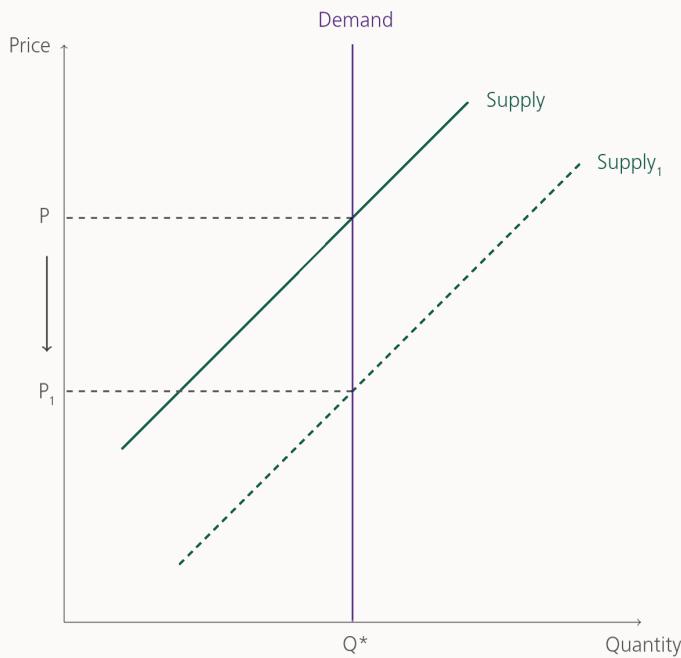
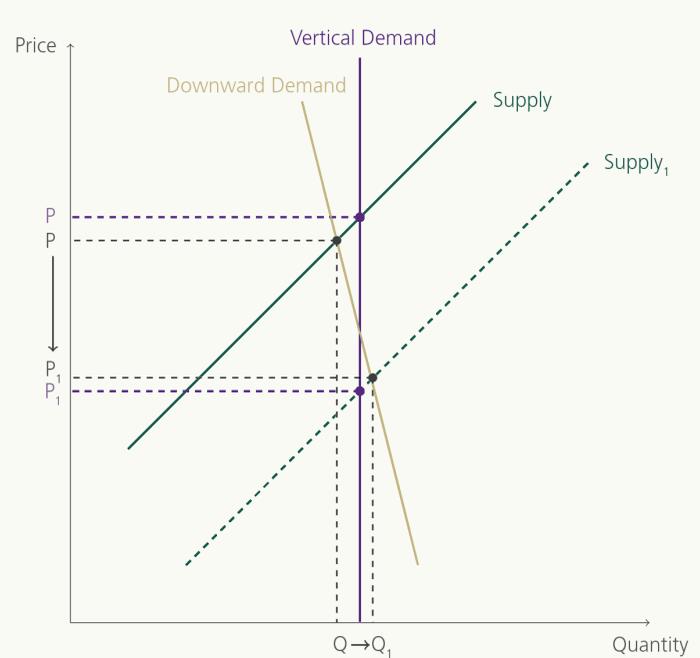


Figure 2: Increase in Supply of Capacity with Downward Sloping Demand Curve



adopting a downward-sloping demand curve. Since the same level of capacity  $Q^*$  is always procured, an increase in the supply of generation capacity, represented by the shift from the solid to the dashed supply curve, causes prices to decrease by a large amount.

With a downward sloping demand curve the same shift has a smaller effect on price, however, it implies that the capacity procured through the auction market may be above or below the planning reserve margin ( $Q^*$ ) as shown in Figure 2. This can be largely addressed through the shape of the demand curve by making the curve above the reserve margin steeper to provide less value to capacity above this level. In addition, downward sloping demand curves are sensitive to the assumptions and reference technologies used to estimate it. Typically, the most important among these assumptions is the ‘cost of new entry’ (CONE) that informs the slope and shape of the curve.<sup>2</sup> Estimation of the CONE value thus has important implications for which technologies will be able to recover their fixed costs in the long run. As a result, the CONE value generally requires updating at regular intervals in order to reflect changing technologies and market conditions.

**Forward and Commitment Periods.** The forward period is the amount of time an auction takes place before the capacity is needed, and the commitment period is the length of time the capacity is required to be available for generation. The duration of these periods affects the distribution of risk, incentives for market entry and exit, and price stability. A longer forward period provides more time for resources to come on line after winning the auction, and thus increases competition among different supply types. In contrast, short forward periods will discourage

<sup>2</sup> See Federal Energy Regulatory Commission, Centralized Capacity Market Design Elements, Appendix A.

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new entry or increase costs of entry, increasing risk to generators. A 3-year forward period is often used, based on the average lead time required for construction of a new gas generation facility. However, a longer forward period decreases the accuracy of the forecast for the amount of capacity needed, shifting some risk onto customers, and longer forward periods are less attractive to some supply technologies such as demand response that are less willing to make commitments far in advance.

Longer commitment periods may increase competition among suppliers, and encourage new entry by creating greater certainty for the recovery of fixed costs. Shorter commitments periods may also create difficulties for securing financing due to the uncertainty around revenue after the initial commitment period ends. As a corollary, longer commitment periods contribute to more stable energy prices since prices are locked-in for longer periods of time. However, longer commitment periods increase the importance of accurate demand forecasts, increasing risks to consumers if market conditions change. An additional argument for longer commitment periods is regulatory certainty, which allows suppliers to develop more efficient long-run bidding and investment plans.

**Defining Capacity.** The definition of the product “capacity” that can take part in the capacity market auction is important in determining the set of technologies making up the supply of generation. Typically, capacity is defined generically in existing markets as products that are able to generate electricity or reduce load as needed so that every megawatt (MW) can be treated equally. However, there are other determinants of system capacity not covered by that definition such as operational characteristics of the system. These include location components that affect transmission constraints, and many capacity markets have bidding by zones. Further, it may be desirable to define the eligible capacity products differentially in order to address particular policy goals or system problems. For example, rapid increases in intermittent renewable generation resources have increased the need for flexible, on-demand generation for load balancing. Defining the operational parameters of capacity resources or performance standards is one way to potentially meet specific system needs. However, this could lead to a significant increase in the complexity of the market both for system operators and suppliers.

A potential disincentive for investment in new technologies in regulated markets is that unsuccessful innovations can still be locked into the utilities’ rates for many years, making regulators wary of trying unproven technologies. In contrast, competitive markets will incent any technology with a sufficiently high risk-adjusted return. Since any product able to generate electricity or reduce load is treated equally in a capacity market, these markets have the potential to draw a diverse supply mix. For example, capacity markets can incentivize gains in energy efficiency since they provide a mechanism for directly compensating gains in efficiency. In the United States, approximately 85% of non-pumped hydroelectric energy storage is in competitive markets, and penetration of renewables is approximately 10.6% of generation in competitive markets versus 6.5 in regulated ones.<sup>3</sup> Similarly, demand response in the US has greater penetration in competitive markets with nearly 29,000 MW of potential peak reduction in 2014 versus less than 13,000 MW in regulated environments.<sup>4</sup>

**Performance Requirements.** Resources that are successful in a capacity auction are subject to performance requirements. Typically, there are two components to these requirements. The first is that the resource is available to produce energy, and the second is a minimum performance standard when energy is produced. Suppliers

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<sup>3</sup> PJM, Resource Investment in Competitive Markets, p.11.

<sup>4</sup> PJM, Resource Investment in Competitive Markets, p.12.

with more outages can be penalized either financially or through eligibility for future auctions. Well-designed performance requirements ensure that generation is available when needed and that suppliers face appropriate incentives to invest in maintenance and upgrades.

Together, these attributes shape the functioning of a competitive capacity market that can secure electricity generation resources in a flexible, efficient, and low cost manner. Currently, however, Ontario is experiencing an excess supply of generation capacity. What, then, is the argument for adopting capacity markets in Ontario at this time?

## ASSESSMENTS OF CAPACITY MARKET FOR ONTARIO

The adoption of a capacity auction in Ontario has been under consideration since at least 2014 when the IESO published a report assessing its potential benefits for cost savings from 2019 to 2032 relative to the current system of long term contracting.<sup>5</sup> According to the 2013 Long Term Energy Plan, the province will experience a capacity shortfall beginning in 2019, largely due to retirement and refurbishment of nuclear generation. In their assessment, the IESO assumes that the cost of meeting Ontario's peak capacity requirements under the current system is approximately \$130,000/MW-year, which is an estimate of the cost of a new Single-Cycle Gas Turbine generation unit. This is compared to the average "all-in cost" of capacity (i.e., average capacity payments plus energy and ancillary services revenues) and Net CONE in the United States' largest capacity markets, the PJM Interconnection, L.L.C. (PJM) and New York Independent System Operator Inc. (NYISO), over the past 5 years. The average Net CONE in \$CDN/MW-year for PJM and NYISO is shown to be comparable to the IESO's costs at \$100,000 and \$122,000, respectively. However, the average capacity clearing price and all-in costs are estimated to be dramatically lower. The IESO estimates average capacity market prices of \$42,900/MW-year for PJM and \$42,700/MW-year for NYISO. All-in costs for both regions are estimated to total \$50,900/MW-year. Thus, the average capacity market clearing prices and all-in costs are significantly lower than the administratively estimated cost of new generation entry in both markets.

A review of the IESO analysis performed by NERA Economic Consulting notes that in PJM, NYISO, and ISO New England (ISO-NE), capacity clearing prices have consistently been lower than economic or engineering estimates of the cost of new entry. They further point out that this is in part due to the fact that administrative estimates are always of the costs of the average marginal unit instead of the best marginal unit, and a competitive market allows suppliers with the lowest costs to succeed. The IESO assessment goes on to examine the clearing prices and all-in costs in the highest priced zones for PJM and NYISO. Together these average \$88,100/MW-year for the capacity clearing price and \$96,200/MW-year for the all-in cost. While the highest priced zones have prices and costs approximately double the average zone, the costs are still substantially less than those assumed by the IESO for Ontario under the current system.

If similar prices could be achieved to procure capacity in Ontario, these estimates suggest the potential for large cost savings for the province by transitioning to a capacity market as current generation contracts expire. In 2014, the IESO estimated these savings at \$250 million to \$500 million per year based on average capacity price figures.

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<sup>5</sup> See IESO, Ontario Capacity Auction: Assessment of Expected Benefits.

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Updated preliminary estimates from The Brattle Group in 2016 produced similar total benefits with a somewhat different distribution over the planning period.

Is there evidence from other jurisdictions to suggest these estimated cost savings can be realized while maintaining adequate generation capacity and promoting a mix of fuel types and innovation?

### EXPERIENCES OF OTHER JURISDICTIONS

The United States has three of the world’s most mature capacity markets, the PJM Interconnection, ISO New England, and New York Independent System Operator, as well as a newer capacity market under the Midcontinent Independent System Operator (MISO). These wholesale electricity markets are operated by regional transmission organizations (RTOs) and independent system operators (ISOs), and are regulated by the Federal Energy Regulatory Commission (FERC). The restructuring of many US electricity markets from traditional regulation to wholesale competition was spurred by the desire for greater operating efficiency and generation performance, and to shift some risk from ratepayers to generators. The attributes and experiences of each of these markets are discussed in turn.

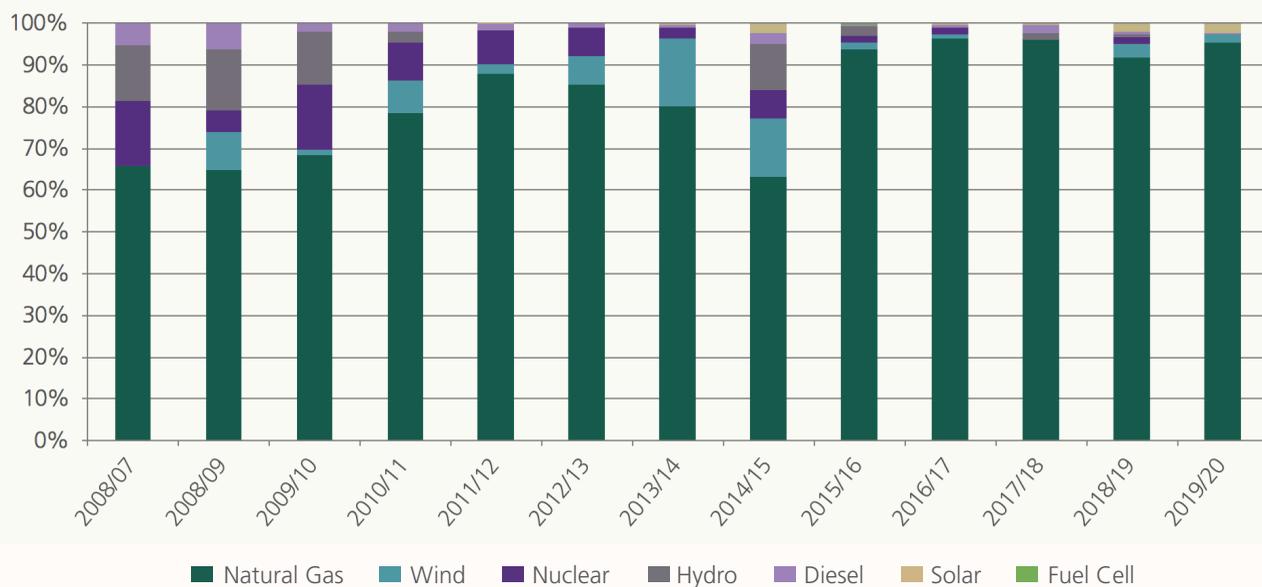
PJM manages a large electric system encompassing 13 states and the District of Columbia. PJM’s capacity market has been in operation for more than 10 years using a centralized capacity auction with a 3-year forward period. The commitment period is 1-year with a 3-year commitment option for some new generators. Initially, a vertical demand curve was employed to determine clearing prices in PJM’s capacity market, but eventually a downward sloping demand curve was adopted due to concerns over price volatility. The forward auction also maintains a price floor to prevent any resources subsidized outside the capacity market from making excessively low bids. In addition to the main forward capacity auction, PJM holds “realignment auctions” to address forecast changes and to act as a secondary market for suppliers as well as a “Conditional Incremental Auction” to account for delays in large projects.

Table 1: PJM Unforced Capacity Procured by Type & Delivery Year (MW)

Delivery Date	New Generation	Generation Upgrades	Imports	Demand Response	Energy Efficiency	Total
2014/15	415.5	341.1	3,016.5	14,118.4	822.1	18,713.6
2015/16	4,898.9	447.4	3,935.3	14,832.8	922.5	25,036.9
2016/17	4,281.6	1,181.3	7,482.7	12,408.1	1,117.3	26,471.0
2017/18	5,927.4	339.9	4,525.5	10,974.8	1,338.9	23,106.5
2018/19	2,954.3	587.6	4,687.9	11,084.4	1,246.5	20,560.7
2019/20	5,373.6	155.6	3,875.9	10,348.0	1,515.1	21,268.2

Source: PJM Interconnection, 2019/2020 RPM Base Residual Auction Results, [www.pjm.com](http://www.pjm.com).

Figure 3: PJM Incremental Capacity Additions by Delivery Year & Fuel



Source: PJM Interconnection, 2019/2020 RPM Base Residual Auction Results, www.pjm.com.

PJM has been successful in attracting investment and clearing capacity from a diverse mix of supply resources. From 2010 to 2015 approximately 24,000 MW of new generation were committed in PJM’s capacity market, 19,500 MW of which were natural gas generation resources. In addition, significant increases in incremental capacity and investment have come from modifications to existing plants (“uprates”). Demand response, imports, and energy efficiency are also an important part of PJM’s capacity procurement. Detail on the historic breakdown of PJM’s incremental and unforced capacity resources cleared are shown in [Table 1](#) and [Figure 3](#).

PJM has also been successful in efficiently dealing with large scale retirement of coal-fired generation plants resulting in large part from the U.S. Environmental Protection Agency’s Mercury and Air Toxics Standards, which set emission standards for hazardous air pollutants from coal- and oil- fired electricity generation. These retirements have been replaced by a combination of low cost new generation, uprates, demand response, and imports.

ISO-NE is a not-for-profit corporation responsible for providing electricity to six states in New England. It has an annual auction for capacity with a 3-year forward period as well as realignment auctions to address forecast updates and to act as secondary market. The commitment period for the auction is 1 year with an option for new generators to contract for 5 years. ISO-NE initially maintained a vertical demand curve and experienced significant excess supply. Consequently, the first seven auctions cleared at the administratively set price floor. The eighth auction in February 2014, however, resulted in a capacity shortfall and, thus, an administratively set scarcity price. Subsequently, ISO-NE implemented a downward sloping demand curve to reduce price volatility. Auction clearing prices and quantities in ISO-NE to date are shown in [Table 2](#). Total capacity in ISO-NE includes a mix of existing generation, new generation, imports, and demand response with approximately 3-6% of cleared capacity filled through imports and 7-10% through demand response. New generation also included a mix of gas, wind, solar, and fuel cell technologies.

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Table 2: ISO-NE Forward Capacity Auction Results by Delivery Year

Auction	Delivery Year	Total Capacity Acquired (MW)	New Demand Resources (MW)	New Generation (MW)	Clearing Price (\$/kW-Month)
1	2010/11	34,077	1,188	626	\$4.50
2	2011/12	37,283	448	1,157	\$3.60
3	2012/13	36,996	309	1,670	\$2.95
4	2013/14	37,501	515	144	\$2.95
5	2014/15	36,918	263	42	\$3.21
6	2015/16	36,309	313	79	\$3.43
7	2016/17	36,220	245	800	\$3.15
8	2017/18	33,712	394	30	\$15.00 (new) \$7.03 (existing)
9	2018/19	34,695	367	1,060	\$9.55
10	2019/20	35,567	371	1,459	\$7.03

Source: ISO New England Inc., [www.iso-ne.com](http://www.iso-ne.com).

NYISO operates the electricity grid and manages wholesale electricity markets for the state of New York. NYISO's capacity market is unusual in operating a prompt capacity market with its longest forward period at 30 days, its longest commitment period at 6 months, and separate auctions for summer and winter capacity. Despite the short forward period, new generation, representing 30% of the current capacity of New York's power plants, has been added since the start of New York's wholesale electricity market. From 2000-2016, those additions totalled more than 11,600 MWs, and more than 80 percent of the new generation has been added in the Hudson Valley, New York City and Long Island, where demand is highest. In addition, demand response and energy efficiency programs are expected to significantly contribute to addressing peak demand. Demand response contributes more than 1,200 megawatts of resources, and energy efficiency is expected to reduce peak demand by 255 megawatts in 2016, growing to more than 1,800 megawatts in 2026. NYISO originally employed a vertical demand curve to determine clearing prices in the capacity market but, as with PJM and ISO-NE, switched to downward sloping demand curve due to concerns over price volatility.

The Midcontinent Independent System Operator (MISO) is involved in delivering power to 15 states and Manitoba. MISO has a newer capacity market with a very different structure from that of PJM, NYISO, or ISO-NE. Currently, MISO operates a voluntary annual capacity auction for nearly immediate delivery that is only one of several ways load-bearing entities can secure required capacity. Due to its unique design, it is difficult to compare MISO to the centralized, forward capacity markets of PJM, NYISO, and ISO-NE. MISO's market design has led to significant problems in attracting investment due, at least in part, to the combination of an extremely short forward period and a "thin" market for capacity. Such "thin" markets, with few buying or selling offers, are known to create a variety of market inefficiencies that can impact both price and risk. As such, concerns have arisen that without intervention MISO may fall short of its reliability standards. Consequently, in November 2016 MISO filed a market restructuring plan with FERC to create a 3-year forward capacity auction with a downward sloping demand curve, similar to that of PJM.

## LESSONS FOR ONTARIO

The introduction of a capacity market for future generation procurement could reduce costs relative to the current system of long-term contracts and increase system efficiency while reducing risks to ratepayers. The experiences of other jurisdictions in implementing capacity markets have many lessons and caveats to take into account in designing such a market for Ontario. Designing successful capacity markets requires a clear understanding of the current resource needs and challenges for competition, investment and resource adequacy in the energy market and developing a market structure consistent with these characteristics. Capacity markets have shown themselves to be able to meet capacity needs competitively through a mix of supply types and technologies and to make uneconomic generators more likely to retire since their costs are not supported by ratepayers. Overall, experience in the United States has shown that competitive capacity markets can be subject to substantial price volatility. This volatility can be moderated by the shape of the demand curve estimated, and all US markets are moving toward the use of downward-sloping demand. However, this volatility is at times a feature of a competitive market that is fundamental to its ability to balance supply and demand pressures.

It is important to note that adopting just a single policy component, such as a capacity market, from another jurisdiction's electricity system is not necessarily a panacea for Ontario's generation investment challenges. Electricity markets are complex arrangements where individual components are closely interconnected, implying that the performance of any one component depends on the performance of others. Naively importing just one element without recognizing such interdependencies is a risky proposition. Successful capacity markets in other jurisdictions rely crucially on well-functioning wholesale energy, ancillary services, and secondary capacity markets.<sup>6</sup> Generators typically require access to wholesale energy and ancillary services markets, in addition to a capacity market, in order to recover fixed costs. Secondary or intermittent capacity markets are also important for the efficient operation of capacity markets, since they allow both the system operator and generators to adjust to changes in demand forecasts or facility construction, upgrade, and refurbishment time lines. Hence, while capacity markets in theory can improve efficiencies in generation, their introduction and design should account for existing institutional features of the electricity system and may require reforms to related components.

Further, promoting goals beyond the provision of reliable electricity at least cost such as job promotion, specific fuel types, etc. reduces the efficiency of the market and can affect its ability to attract investment, suppress clearing prices or crowd out competitive unsubsidized resources. Because demand curves for capacity markets are either vertical or steeply downward sloping, even small subsidies can have significant effects on market prices. Thus, proper governance is crucial to obtaining the greatest benefits from a capacity market. The large regional capacity markets of the United States have the benefit that they span multiple political entities and, consequently, are less subject to government policy decisions that would affect their markets. In the words of Crampton and Ockenfels (2012), "...a capacity market does little to protect against the harm caused by politically induced uncertainties."

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<sup>6</sup> Ancillary services include a variety of services that contribute to the reliability and security on the electrical grid.

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