Education and Awareness

Energy Workstream High-Level Designs

Variable Generators

December 3, 2018

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Purpose and Approach

- This exercise will provide education and practical understanding of the key aspects of the Energy High-Level Designs (HLDs)
- Focus of today will be on design decisions that are most impactful to Variable Generators
- The presentation is split into three sections:
  A. Summary of the relevant core design concepts
  B. High-level walk through of operational activities to compare new design features to the current design
  C. Settlement scenarios relevant to the resource group

SECTION A: DESIGN CONCEPTS

Introduction

- This section will begin with a recap of the rationale for Market Renewal, and summarize the key initiatives in the energy work stream
- The presentation will then outline the key design concepts most relevant for VG including:
  1. Locational Pricing
  2. Day-Ahead Market Participation
  3. Market Power Mitigation

Market Renewal Overview

- Ambitious set of initiatives that amounts to a fundamental redesign of Ontario's electricity markets and **prepares us for future change**
- Current design has served Ontario well but demands of a modern **grid evolving rapidly**
- **Reforms are required** to allow the IESO to continue to manage the grid reliably & cost effectively

Market Renewal Activities

ENERGY work stream

- Single Schedule Market (SSM)
- Day-Ahead Market (DAM)
- Real-Time Unit Commitment (ERUC)

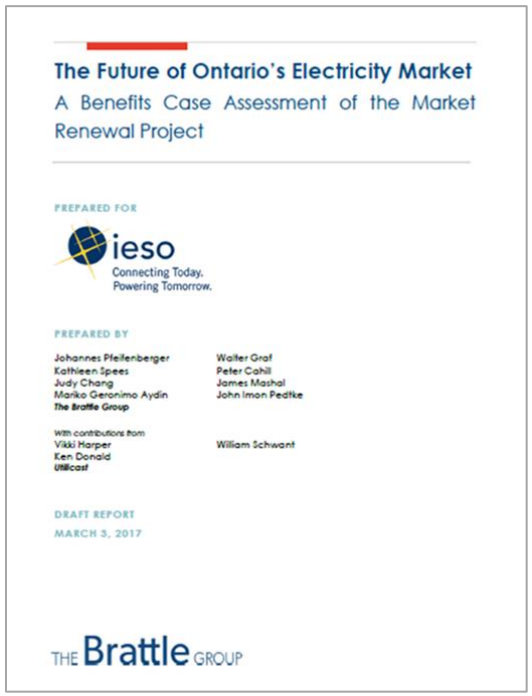
CAPACITY work stream

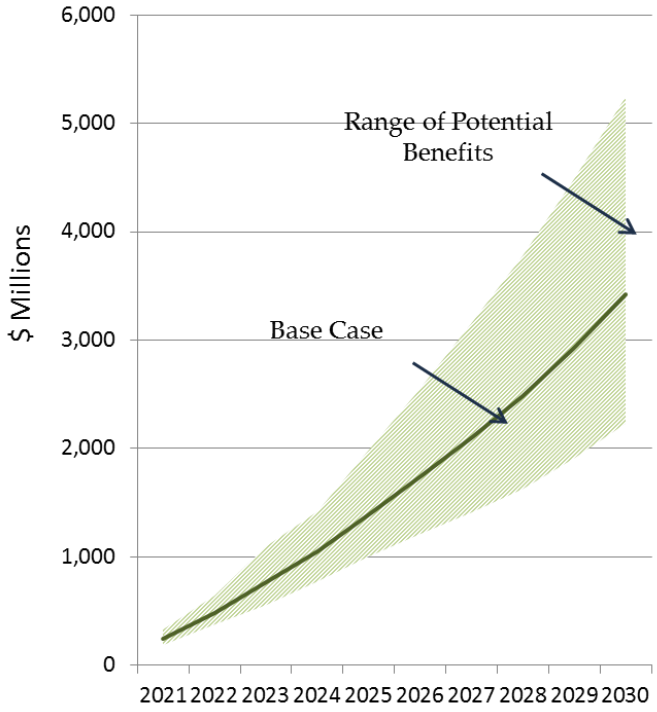
- Incremental Capacity Auction (ICA)

Near-term Projects → **Market Renewal** → Future Projects

Developing a Benefits Case

The IESO spent eight months analyzing the potential benefits of market renewal together with stakeholders under a range of future scenarios.





Market Renewal is expected to deliver an average of **$3.4 billion in efficiency savings** (most of which will flow to Ontario's consumers) over a 10-year period with a potential to reach as high as $5.2 billion.

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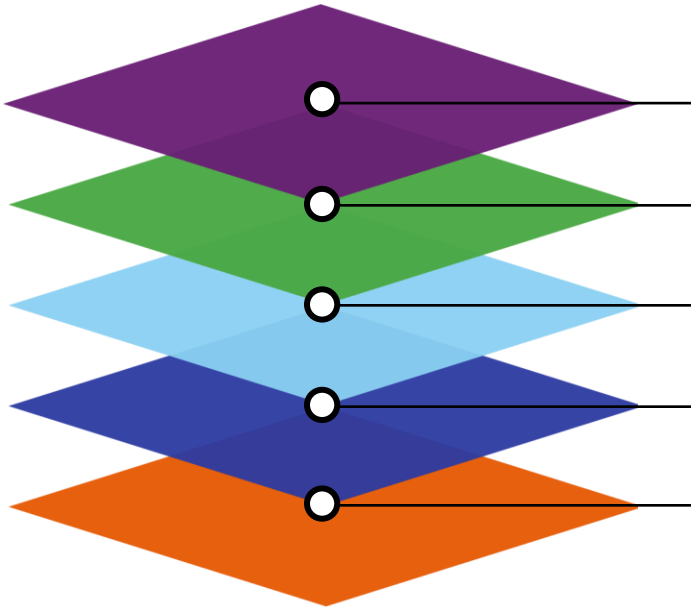
Market Renewal Principles

A more efficient, stable marketplace with competitive and transparent mechanisms that meet system and participant needs at lowest cost.



Efficiency

Competition

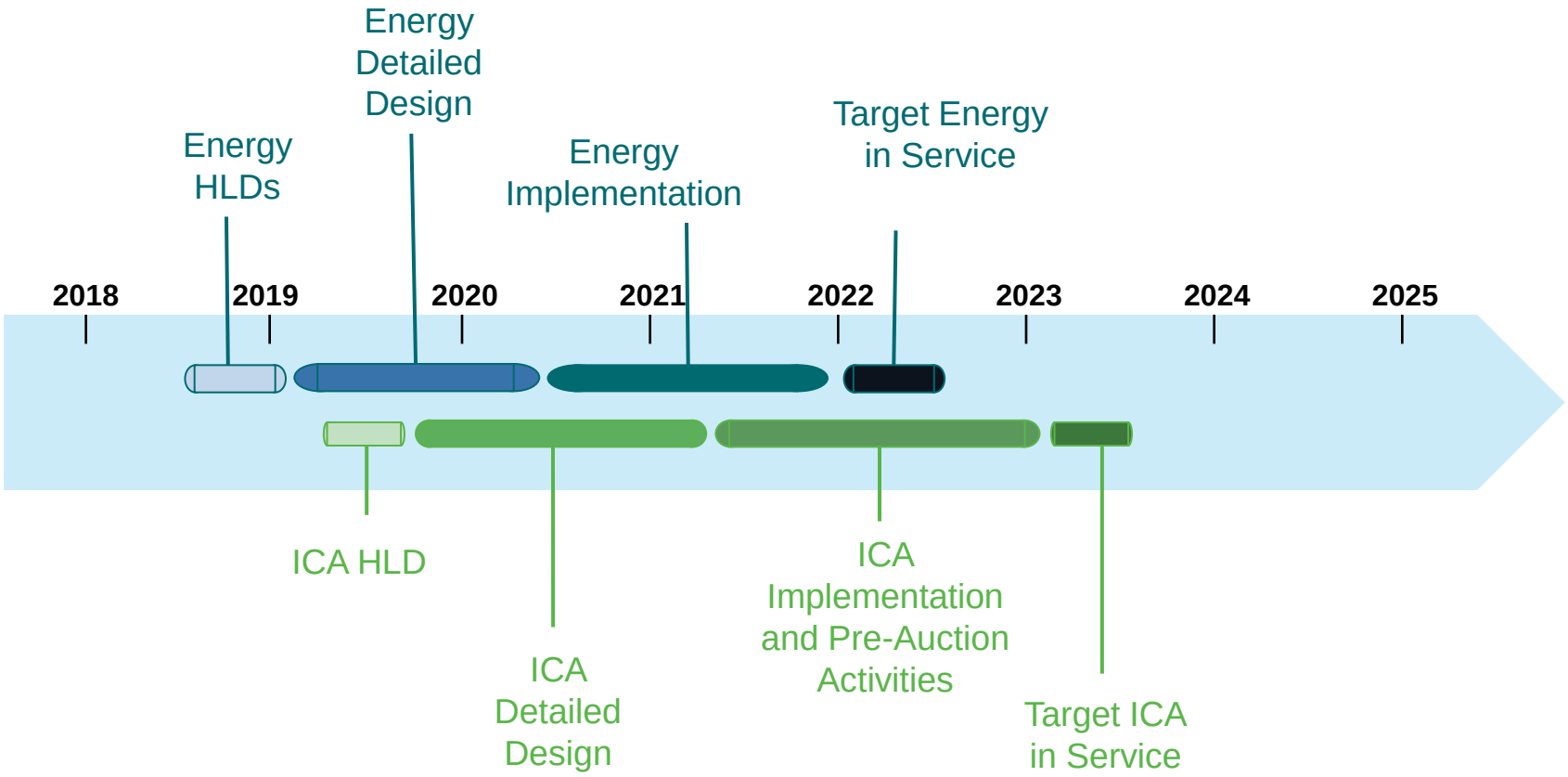
Implementability

Certainty

Transparency

Market renewal must meet Ontario's reliability needs and work within public policy parameters

Market Renewal Timeline



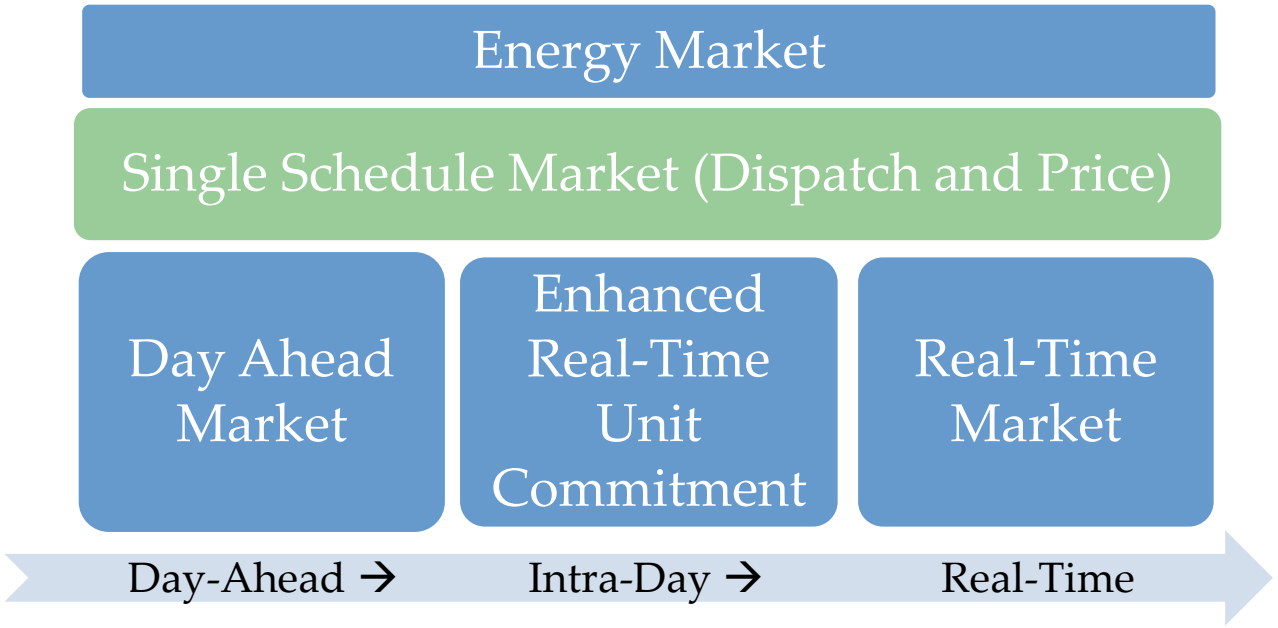
**This graphic is for illustrative purposes only and dates are subject to change*

Market Renewal and Contracts

- Market Renewal is focused on improving the efficiency of Ontario's electricity markets, consistent with contract provisions and fairness to all contract counterparties, the IESO is not targeting to extract value from contracts
- The IESO will continuously work with our contract counterparties to understand contract implications, and address these changes throughout the design of the MRP

Single Schedule Market - The Big Picture

- This initiative will replace Ontario's two schedule market with a single schedule market (SSM) that better aligns price with dispatch
- Improving the energy price signal in Ontario is a foundational change that is required to address existing challenges and prepare for the market of the future



Ontario's Current Market Design

Ontario's current market uses two different schedules (sets of calculations) to determine price and dispatch in Ontario

Schedule 1

- Determines a province-wide uniform price for energy (MCP)
- Ignores certain physical limitations of the system
- Used to settle the market financially

When there are differences between the two schedules, out-of-market CMSC* payments must be made to maintain reliability

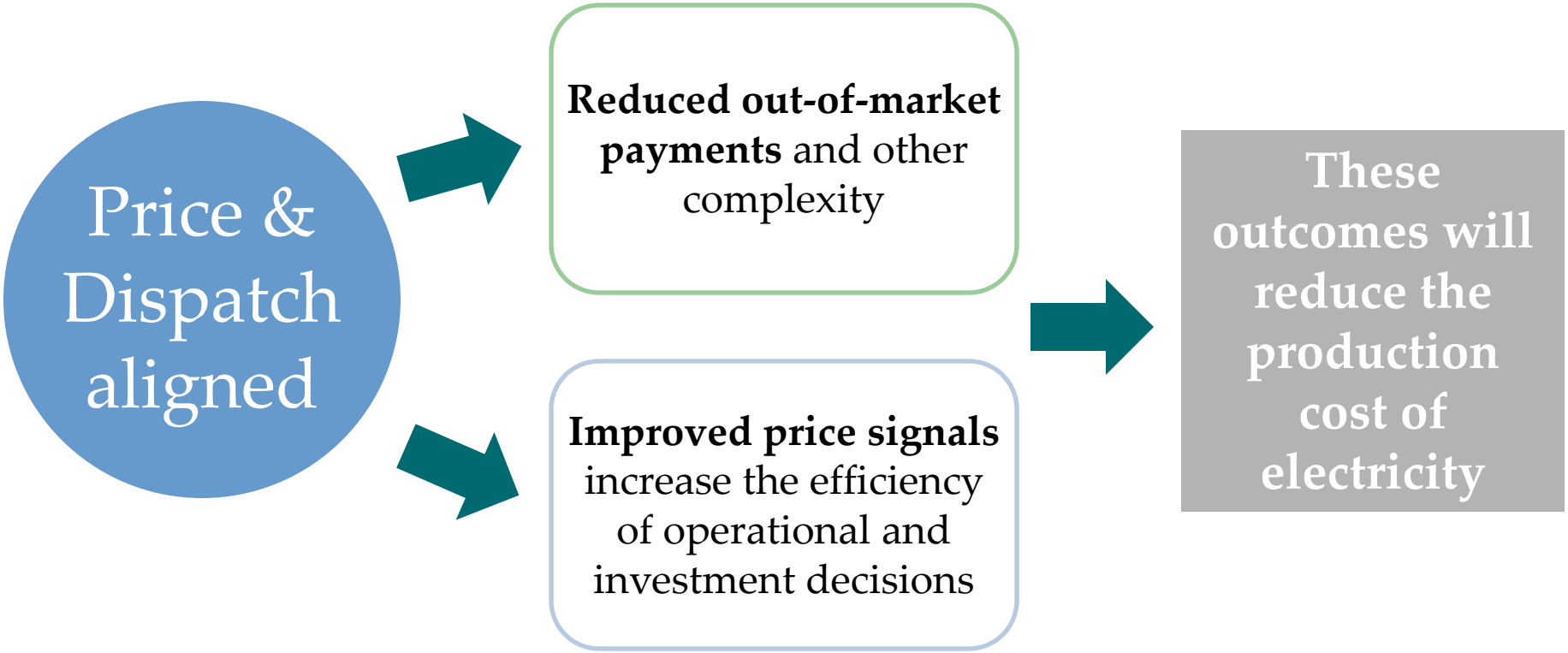
These payments have led to inefficient behaviour and costly outcomes for consumers

Schedule 2

- Calculates "shadow" prices at each node
- Considers all relevant physical limitations of the system
- Prices used to dispatch resources

CMSC = Congestion Management Settlement Credit

Single Schedule Market



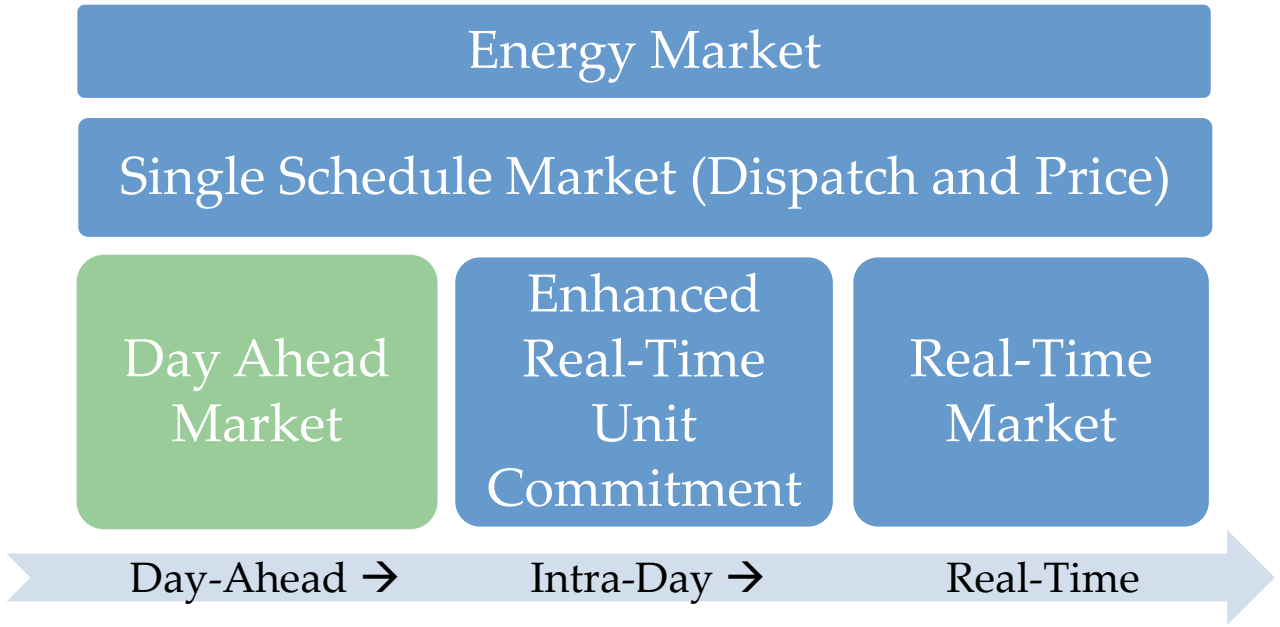
Enabled by Single Schedule Market

Single Schedule Market – Key Takeaways

- SSM will introduce locational prices for energy and operating reserve that will more accurately reflect the value of those services, enabling more efficient operational and investment decisions
- Unlocks other market changes including the day-ahead market
- Not seeking to extract value from contracted resources
- Allows resources that can provide the most value to the system to benefit from accurate locational prices

Day-Ahead Market: The Big Picture

- A day-ahead market will provide financially binding day-ahead schedules
- It is enabled by the single schedule market design and will operate prior to pre-dispatch and real-time



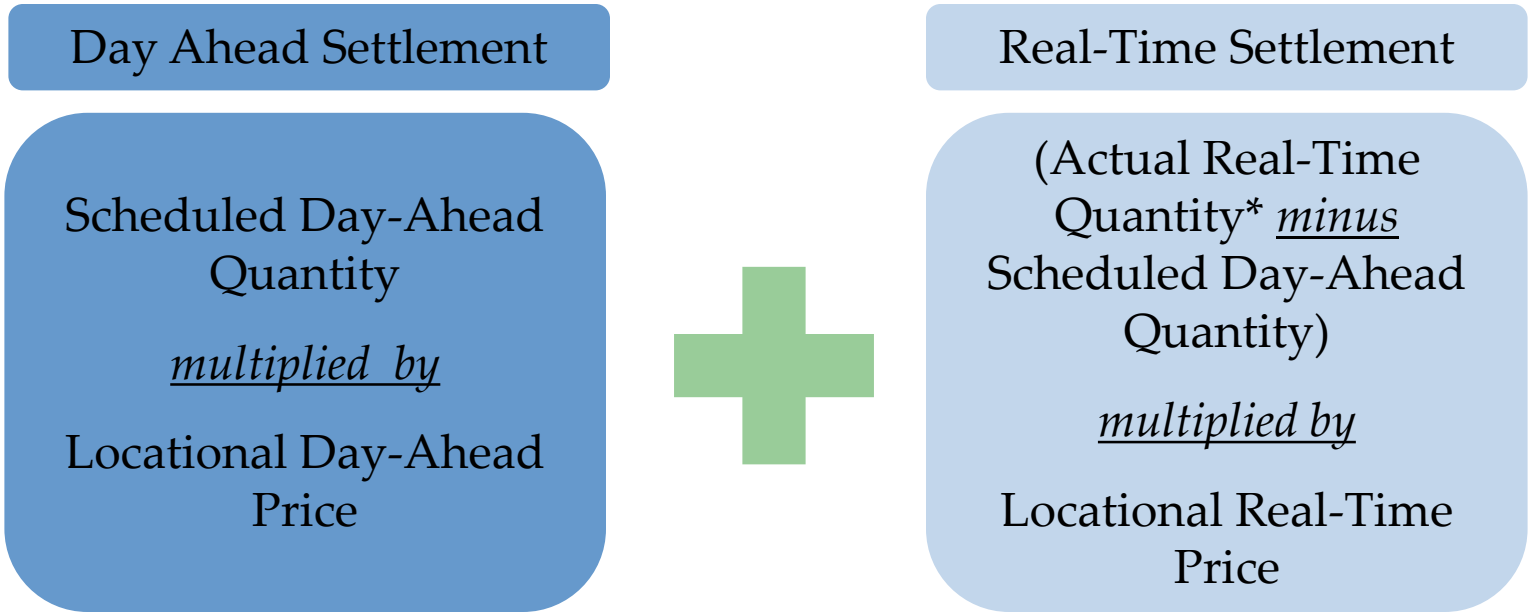
Why a Day Ahead Market?

Current Day-Ahead Commitment Process (DACP)	Day-Ahead Market (DAM)
• Participants submit day-ahead bids and offers primarily to declare availability in real-time.	• Participants submit day-ahead bids and offers to compete with other for a day-ahead price.
• Day-ahead bids and offers may be less efficient because they are not competing for a price	• Day-ahead bids and offers are more efficient because they are competitive
• Exports can participate but are not incentivized to do so	• Exports have incentive to participate in the DAM
• Resources are scheduled to meet Ontario demand, providing a rough approximation of tomorrow's operation	• Resources are scheduled to meet total Market demand, providing a better view of tomorrow's operation

A day-ahead price signal incentivizes more efficient participation from all resources

How it Works

- DAM produces hourly schedules and prices that are financially binding, introducing a 'two-settlement' system



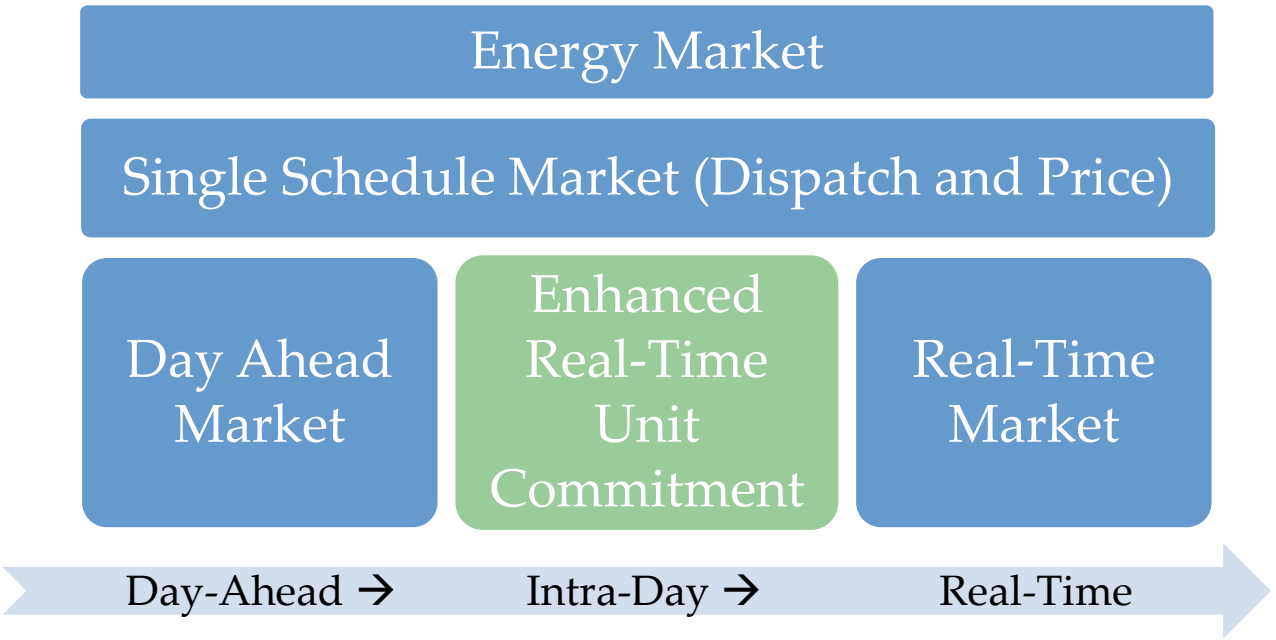
- Real-time settlement only used for balancing deviations from day-ahead schedules

Day-Ahead Market – Key Takeaways

- Financially binding DAM will improve participation in day-ahead scheduling, helping to ensure reliability while efficiently scheduling resources
- Participation in the DAM will not be mandatory, however; participation can help to reduce exposure to real-time price volatility
- *Note: These topics are discussed in greater detail in the key concepts section of the presentation*

ERUC: The Big Picture

- Enhanced real-time unit commitment will operate in the pre-dispatch timeframe, after day-ahead / before real-time



Summary of Issues with Current Real-time Unit Commitment Process

Incomplete Picture

Not all costs are considered in optimization process

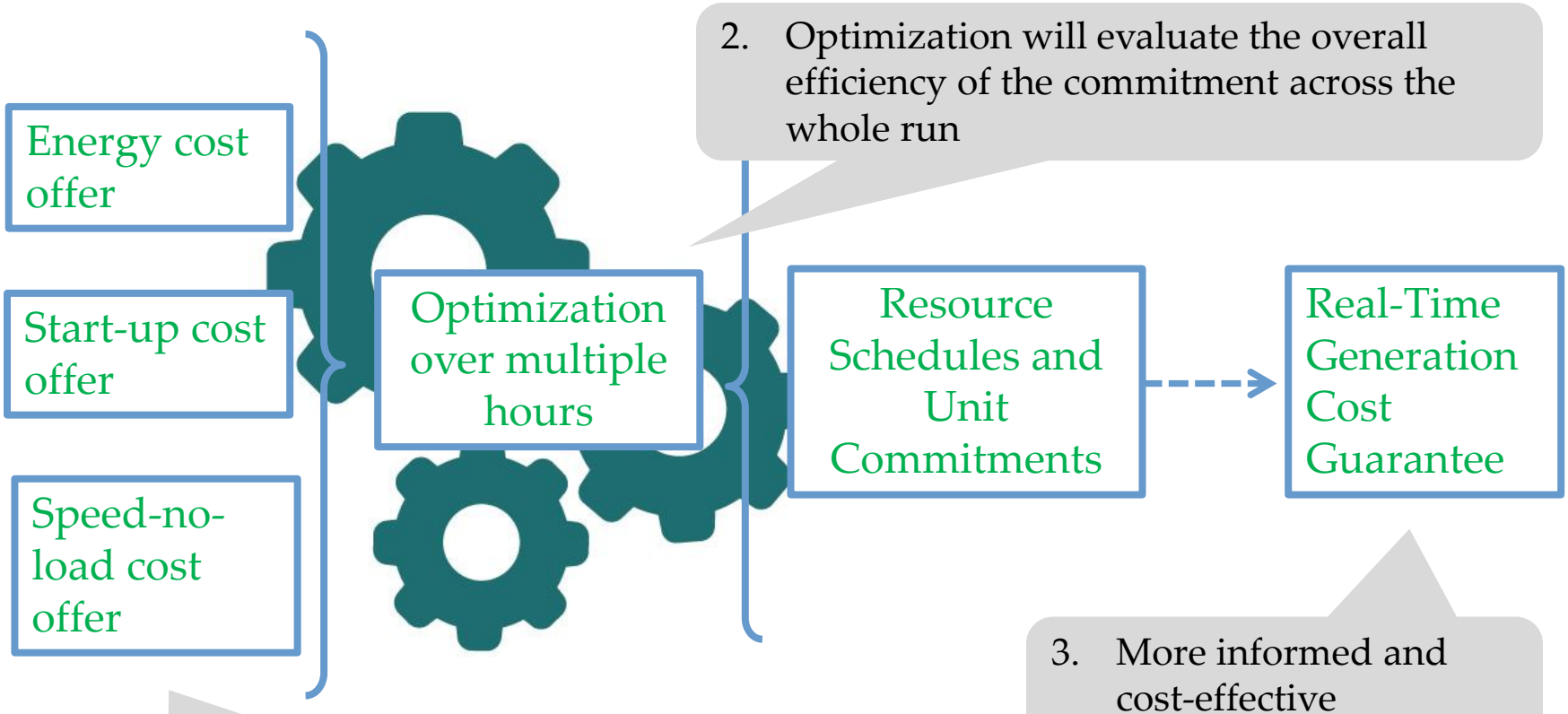
Lack of Competition

After-the-fact cost submission means no competition between generators on those costs

Limited look-ahead

Optimizes commitments based on a single hour

Enhanced Real-Time Unit Commitment Process



2. Optimization will evaluate the overall efficiency of the commitment across the whole run

3. More informed and cost-effective commitment decisions

1. Resources will be efficiently committed by considering all costs

Enhanced Real-Time Commitment – Key Takeaways

- The ERUC project is replacing today's pre-dispatch process and the Real-Time Generator Cost Guarantee program
- Improved pre-dispatch process will help to ensure that resources are scheduled when they are among the lowest cost options
  - Improved optimization will avoid instances of higher cost resources being committed ahead of more competitive options

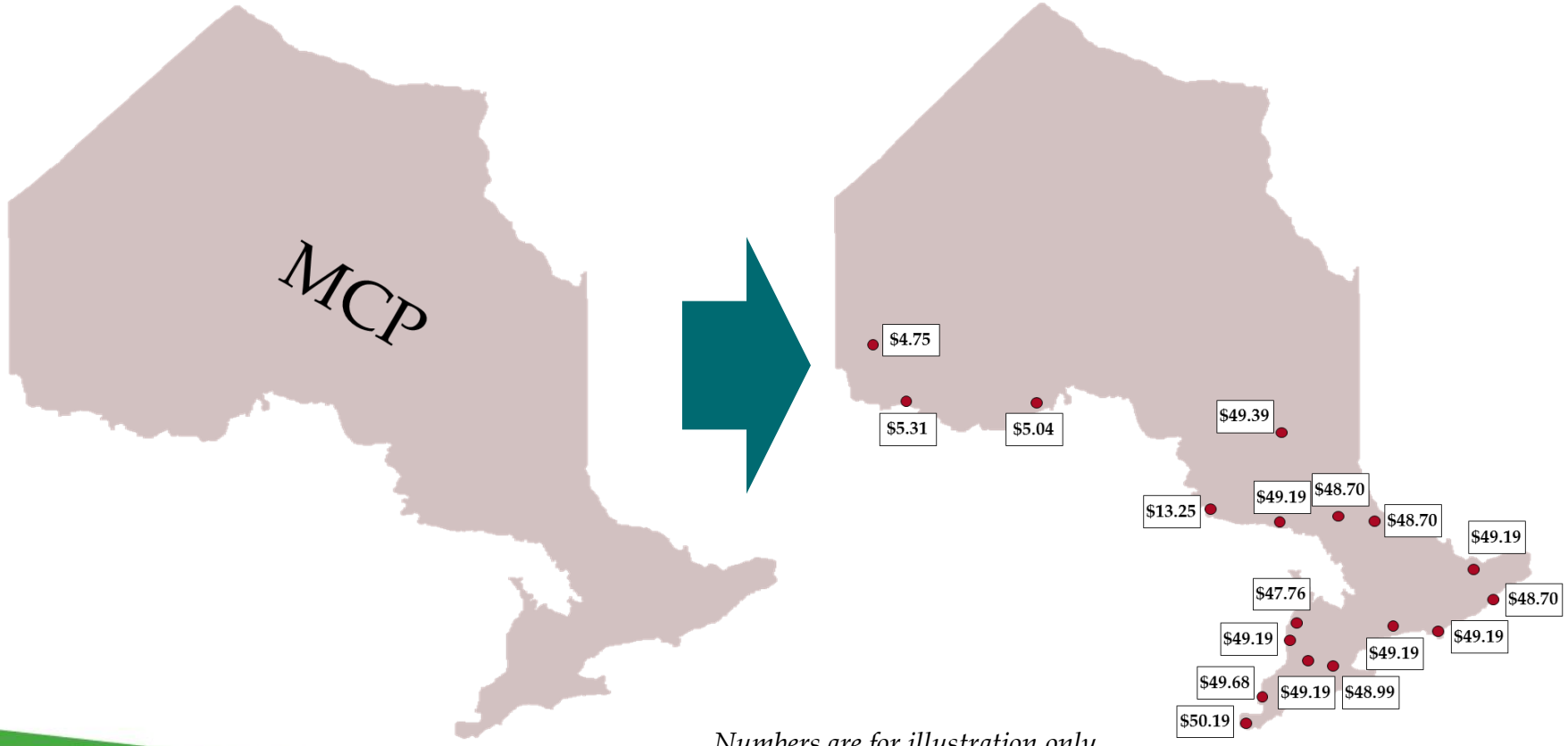
KEY DESIGN CONCEPTS

Context

- Locational Marginal Pricing (LMP) is a foundational feature of Market Renewal
- Locational prices will:
  - ✓ Align price with dispatch
  - ✓ Significantly reduce out-of-market payments
  - ✓ Unlock broader market renewal benefits
  - ✓ Reduce the cost of energy for Ontario consumers

Design for Suppliers

Generators will move from MCP to nodal pricing:



Numbers are for illustration only

Pricing Summary

Participant	Customer Class	Current settlement price:	SSM settlement price:
IESO-Settled Loads	Dispatchable Loads	Uniform Market Clearing Price (MCP)	Nodal
	Non-dispatchable Loads (including LDCs)	HOEP	Zonal with Nodal option
LDC-Settled Loads	Large Customers (>250,000KWh)	HOEP	TBD by OEB
	Small Customers (<250,000 KWh)	RPP	
Suppliers	N/A	Uniform Market Clearing Price (MCP)	Nodal

Context

Key design aspects of day-ahead market design that are most relevant for VGs include:

1. The DAM will not have a specific obligation to participate

2. Participation requires submission of prices and quantity *(using IESO or own forecast)*

3. Participation will allow VGs to reduce exposure to real-time price volatility

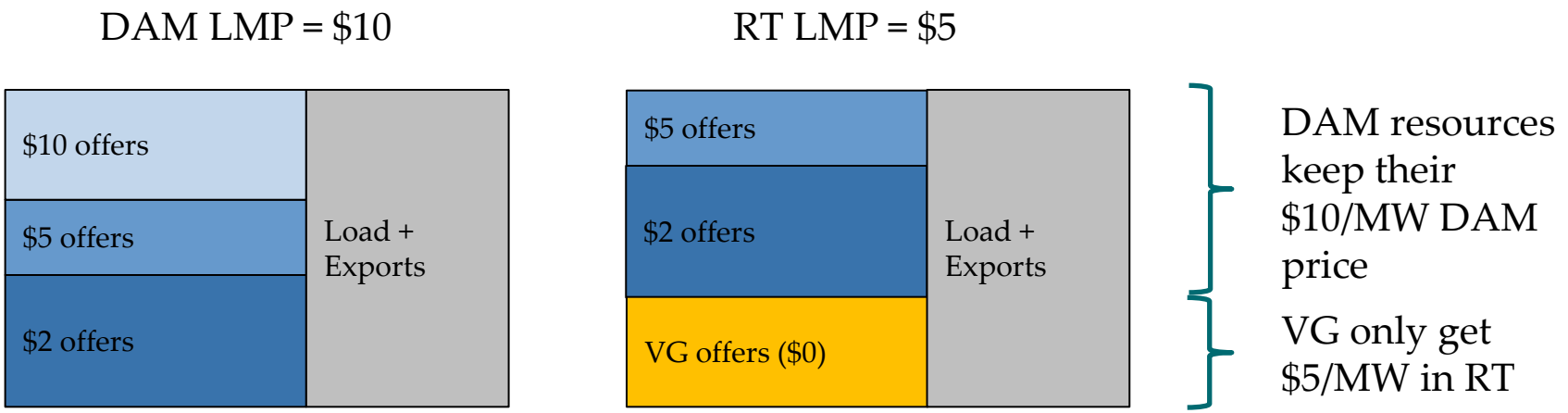
4. IESO centralized forecast will continue to be used to schedule VG in pre-dispatch and real-time for reliability

Non Participation

- VG may choose to limit their DAM participation to avoid real-time balancing costs due to forecast uncertainty
  - This approach can introduce other financial and operational risks
- Participants should understand risks associated with limited DAM participation when determining their offer strategies:
  - Increased exposure to real-time price volatility;
  - Being partially or entirely prevented from being dispatched in real-time; and
  - Potential penalties for physically withholding from DAM

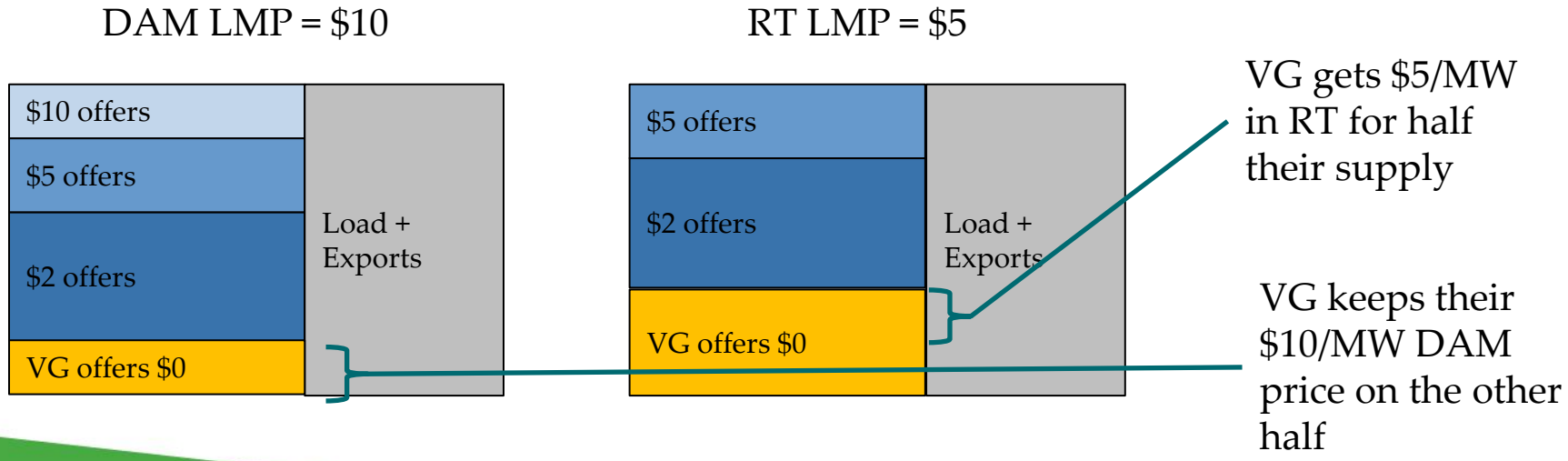
Exposure to Lower Real-time Prices

- Not offering all or a portion of expected RT supply in the DAM can suppress real-time market prices
  - Resources risk forgoing a higher DAM price for all or some of their supply



Minimizing Exposure to Lower RT Prices

- Resources should offer into DAM their expected RT output in order to maximize their revenues
- Offering into the DAM can lock in a higher price on all or a portion of their supply



Summary

	Participate in day-ahead market	Do not participate in day-ahead market
Actions	• Submit offer price and quantity using either IESO forecast or own forecast	• Do nothing
Implications	• Revenue certainty from day-ahead schedule • Energy market revenue less exposed to real-time price volatility	• Energy market revenue fully exposed to real-time price volatility and dispatch • Some potential penalties for physically withholding in day-ahead market

Context

- Prices impacted by market power do not reflect marginal costs and result in inefficient outcomes that drive up costs to consumers
- Market power can be exercised through:

Economic Withholding

To offer a portion of or all available capacity at a higher than competitive price

Physical Withholding

To not offer a portion or all available capacity into the market

Application

- Market power mitigation (MPM) will be triggered where the IESO determines competition to be restricted
- MPM will apply to energy, operating reserve and certain operational parameters
- MPM will be applied through conduct and impact tests:
  - **Conduct test:** defines the boundaries within which participants will not be mitigated. The test will be based on reference levels which will provide proxies of competitive offers
  - **Impact test:** defines how much of an impact that offers in excess of the conduct threshold can have on market prices before mitigation is applied

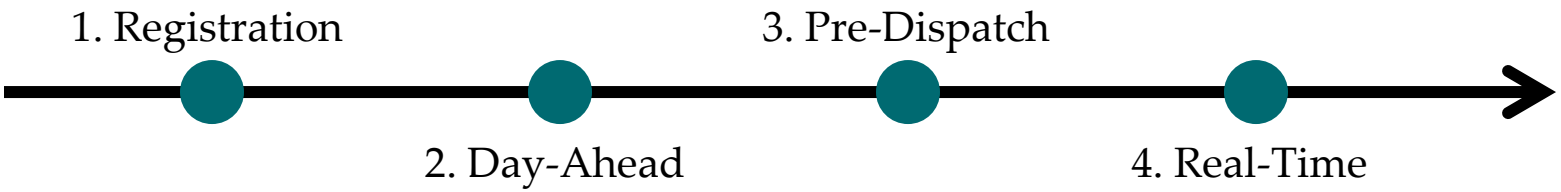
Summary for Suppliers

	Economic Withholding	Physical Withholding
Tests	*Conduct and impact tests* ***Conduct test**: Are offers/operational parameters beyond competitive thresholds?* ***Impact test**: Will settlement costs be beyond set threshold?*	*Conduct and impact tests* ***Conduct test**: Did resource not offer all available capacity?* ***Impact test**: Were settlement costs beyond set threshold?*
Timing	*Before DAM, PD and RT schedules are produced*	*After energy delivery*
Test standard	*Both conduct and impact tests failed*	
IESO Response to Failed Tests	*Offers adjusted to reference levels before scheduling*	*Settlement Adjustment*

SECTION B: OPERATIONAL WALK THROUGH

Introduction

- The section will compare the most relevant new design features to the current design
- This will be illustrated chronologically through four stages:



- The section will start with a recap of the current design before then moving on to describe the new design

1. Registration – Current Design

Registration	Day-Ahead Commitment Process (DACP)	Pre-Dispatch (PD)	Real-Time (RT)
Register resource, including operational data			

2. Day-Ahead – Current Design

Registration	Day-Ahead Commitment Process (DACP)	Pre-Dispatch (PD)	Real-Time (RT)
Register resource, including operational data	Submit offer prices and available capacity *DACP offer requirement to participate in RT (i.e., ADE)* *IESO submits offer quantities based on centralized forecast* Receive DACP schedule		

3. Pre-Dispatch – Current Design

Registration	Day-Ahead Commitment Process (DACP)	Pre-Dispatch (PD)	Real-Time (RT)
Register resource, including operational data	Submit offer prices and available capacity	Update offer prices and available capacity	
	DACP offer requirement to participate in RT (i.e., ADE)	*IESO updates offer quantities based on centralized forecast*	
	IESO submits offer quantities based on centralized forecast	Receive PD schedule	
	Receive DACP schedule		

4. Real-Time – Current Design

Registration	Day-Ahead Commitment Process (DACP)	Pre-Dispatch (PD)	Real-Time (RT)
Register resource, including operational data	Submit offer prices and available capacity	Update offer prices and available capacity	Generate as per dispatch instructions
	DACP offer requirement to participate in RT (i.e., ADE)	*IESO updates offer quantities based on centralized forecast*	*Settlement based on RT generation and uniform market clearing price (MCP)*
	IESO submits offer quantities based on centralized forecast	Receive PD schedule	
	Receive DACP schedule		

1. Registration – Market Renewal Design

Registration	Day-Ahead Market (DAM)	Pre-Dispatch (PD)	Real-Time (RT)
Register resource, including operational data			

2. Day-Ahead – Market Renewal Design

Registration	Day-Ahead Market (DAM)	Pre-Dispatch (PD)	Real-Time (RT)
Register resource, including operational data	*No DAM offer requirement to participate in RT* To participate in DAM: submit offer price and quantity (IESO forecast quantity or own view) MPM checks Receive financially binding schedule *DAM settlement based on financially binding schedule and nodal price*		

3. Pre-Dispatch – Market Renewal Design

Registration	Day-Ahead Market (DAM)	Pre-Dispatch (PD)	Real-Time (RT)
Register resource, including operational data	*No DAM offer requirement to participate in RT*	Submit/update offer prices and available capacity	
	To participate in DAM: submit offer price and quantity (IESO forecast quantity or own view)	*IESO updates offer quantities based on centralized forecast*	
	MPM checks	MPM checks	
	Receive financially binding schedule	Receive PD schedule	
	DAM settlement based on financially binding schedule and nodal price		

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4. Real-Time – Market Renewal Design

Registration	Day-Ahead Market (DAM)	Pre-Dispatch (PD)	Real-Time (RT)
Register resource, including operational data	*No DAM offer requirement to participate in RT*	Submit/update offer prices and available capacity	Generate as per dispatch instructions
	To participate in DAM: submit offer price and quantity (IESO forecast quantity or own view)	*IESO updates offer quantities based on centralized forecast*	*RT settlement based on real-time generation and nodal price*
	MPM checks	MPM checks	
	Receive financially binding schedule	Receive PD schedule	
	DAM settlement based on financially binding schedule and nodal price		

SECTION C: SETTLEMENT SCENARIOS

Introduction

- This section will provide a series of simplified examples to illustrate the high-level settlement process for dispatchable generators
- Three scenarios will be presented:
  1. Real-Time energy production equal to Day-Ahead schedule
  2. Real-Time energy production greater than Day-Ahead schedule
  3. Real-Time energy production less than Day-Ahead schedule

Settlement for Suppliers

Day-Ahead	Real-Time (balancing)
Scheduled Day-Ahead Quantity *multiplied by* Locational Day-Ahead Price	(Actual Real-Time Quantity* *minus* Scheduled Day-Ahead Quantity) *multiplied by* Locational Real-Time Price
Suppliers are **paid for DA scheduled injections**	Suppliers are **paid for incremental RT** injections but **pay for undelivered DA scheduled injections**

**Scheduled Real-Time Quantity for Operating Reserve*

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Scenario 1:

REAL-TIME PRODUCTION AND DAY-AHEAD SCHEDULE EQUAL

S1: RT and DAM injection equal

Offers	Locational Day-Ahead	Locational Real-Time
100 MW at $0 150 MW at $10		

The supplier makes two offers: one offer to show that it is willing to inject 100 MW as long as the price is greater than or equal to $0 and another to indicate it will inject an additional 150 MW if the price is greater than or equal to $10

S1: RT and DAM injection equal

Offers	Locational Day-Ahead	Locational Real-Time
100 MW at $0 150 MW at $10	Market clears at $100 Supplier scheduled at 250 MW	
Energy settlement	250 MW x $100 = $25,000	

The locational day-ahead market clears at $100 and the supplier receives a financially binding schedule for 250 MW…

Locational day ahead settlement = (Day-Ahead Quantity x Day-Ahead Price)

S1: RT and DAM injection equal

Offers	Locational Day-Ahead	Locational Real-Time
100 MW at $0 150 MW at $10	Market clears at $100 Supplier scheduled at 250 MW	Market clears at $50 Supplier injects 250 MW
Energy settlement	250 MW x $100 = $25,000	(250 MW – 250 MW) x $50 = $0

The supplier's real-time injection is the same as its day-ahead schedule so no balancing settlement applies…

Locational Real-Time settlement = (Real-Time Quantity - Day-Ahead Quantity) x Real-Time Price

S1: RT and DAM injection equal

Offers	Locational Day-Ahead	Locational Real-Time
100 MW at $0 150 MW at $10	Market clears at $100 Supplier scheduled at 250 MW	Market clears at $50 Supplier injects 250 MW
Energy settlement	250 MW x $100 = $25,000	+ (250 MW – 250 MW) x $50 = $0

The supplier is paid $25,000 for injecting 250 MW

Locational day ahead settlement = (Day-Ahead Quantity x Day-Ahead Price), Locational Real-Time settlement = (Real-Time Quantity - Day-Ahead Quantity) x Real-Time Price

S1: RT and DAM injection equal – Summary

- In this scenario, the supplier placed two offers in the DAM which were both accepted at the locational market clearing price
- The participant's real-time injection matched it's day-ahead schedule, and as a result, the supplier was not exposed to the fall in real-time prices
- Overall, this scenario demonstrates how participants can increase financial certainty when they offer into DAM their expected real-time capability

Scenario 2:

REAL-TIME PRODUCTION GREATER THAN DAY-AHEAD SCHEDULE

S2: RT injection greater than DAM

Offers	Locational Day-Ahead	Locational Real-Time
100 MW at $0 150 MW at $10		

The supplier makes two offers: one offer to show that it is willing to inject 100 MW as long as the price is greater than or equal to $0 and another to indicate it will inject an additional 150 MW if the price is greater than or equal to $10

S2: RT injection greater than DAM

Offers	Locational Day-Ahead	Locational Real-Time
100 MW at $0 150 MW at $10	Market clears at $5 Supplier scheduled at 100 MW	
Energy settlement	100 MW x $5 = $500	

The locational day-ahead market clears at $5 and the supplier receives a financially binding schedule for 100 MW…

Locational day ahead settlement = (Day-Ahead Quantity x Day-Ahead Price)

S2: RT injection greater than DAM

Offers	Locational Day-Ahead	Locational Real-Time
100 MW at $0 150 MW at $10	Market clears at $5 Supplier scheduled at 100 MW	Market clears at $50 Supplier injects 250 MW
Energy settlement	100 MW x $5 = $500	(250 MW – 100 MW) x $50 = $7,500

The locational real-time market clears at a higher price than the locational day-ahead market and the participant injects an additional 150 MW…

Locational Real-Time settlement = (Real-Time Quantity - Day-Ahead Quantity) x Real-Time Price

S2: RT injection greater than DAM

Offers	Locational Day-Ahead	Locational Real-Time
100 MW at $0 150 MW at $10	Market clears at $5 Supplier scheduled at 100 MW	Market clears at $50 Supplier injects 250 MW
Energy settlement	100 MW x $5 = $500	+ (250 MW – 100 MW) x $50 = $7,500

The supplier is paid $8,000 for injecting 250 MW

Locational day ahead settlement = (Day-Ahead Quantity x Day-Ahead Price), Locational Real-Time settlement = (Real-Time Quantity - Day-Ahead Quantity) x Real-Time Price

S2: RT injection greater than DAM – Summary

- In this scenario, the supplier placed two offers in the DAM, of which only one was accepted given the locational day-ahead market clearing price
- In real-time, the participant increased injection from the DAM schedule due to higher prices in real-time
- Overall, the scenario illustrates how the supplier had certainty day-ahead on the price of its first 100 MW of supply and had the flexibility to capture higher real-time prices for the remaining 150 MW

Scenario 3:

REAL-TIME PRODUCTION LESS THAN DAY-AHEAD SCHEDULE

S3: RT injection less than DAM

Offers	Locational Day-Ahead	Locational Real-Time
100 MW at $0 150 MW at $10		

The supplier makes two offers: one offer to show that it is willing to inject 100 MW as long as the price is greater than or equal to $0 and another to indicate it will inject an additional 150 MW if the price is greater than or equal to $10

S3: RT injection less than DAM

Offers	Locational Day-Ahead	Locational Real-Time
100 MW at $0 150 MW at $10	Market clears at $50 Supplier scheduled at 250 MW	
Energy settlement	250 MW x $50 = $12,500	

The locational day-ahead market clears at $50 and the supplier receives a financially binding schedule for 250 MW…

Locational day ahead settlement = (Day-Ahead Quantity x Day-Ahead Price)

S3: RT injection less than DAM

Offers	Locational Day-Ahead	Locational Real-Time
100 MW at $0 150 MW at $10	Market clears at $50 Supplier scheduled at 250 MW	Market clears at $5 Supplier injects 100 MW
Energy settlement	250 MW x $50 = $12,500	(100 MW – 250 MW) x $5 = -$750

The locational real-time market price clears lower than the locational day-ahead price and the supplier injects 150 MW less than its financially binding day-ahead schedule…

Locational Real-Time settlement = (Real-Time Quantity - Day-Ahead Quantity) x Real-Time Price

S3: RT injection less than DAM

Offers	Locational Day-Ahead	Locational Real-Time
100 MW at $0 150 MW at $10	Market clears at $50 Supplier scheduled at 250 MW	Market clears at $5 Supplier injects 100 MW
Energy settlement	250 MW x $50 = $12,500	+ (100 MW – 250 MW) x $5 = -$750

The supplier pays $750 to buy back 150 MW of its day-ahead schedule and gets a net payment $11,750 for injecting 100 MW

Locational day ahead settlement = (Day-Ahead Quantity x Day-Ahead Price), Locational Real-Time settlement = (Real-Time Quantity - Day-Ahead Quantity) x Real-Time Price

S3: RT injection less than DAM – Summary

- In this scenario, the supplier placed two offers, which were both accepted given the locational day-ahead market clearing price
- The locational clearing price then dropped in the real-time market and the market participant reduced their injection and bought back the difference
- This scenario illustrates how a participant gains financial certainty through the locational DAM by offering in their expected real-time capability. In this case, the supplier profited from offering into the locational DAM even though the locational real-time market required less supply

WRAP-UP

Summary

- Market Renewal will help to more efficiently deliver a reliable supply of energy to Ontarians
- Existing contracts and regulation will help to ease the transition to a new market design for suppliers
- Best practice and stakeholder feedback are being leveraged to develop a practical market design that works for Ontario suppliers
- The single schedule market will provide a more accurate locational signal for the value of energy and OR in Ontario allowing the resources that are best able to meet system needs to benefit
- DAM and ERUC will help to ensure that resources will be scheduled when they are the lowest cost option to meet system needs

How To Get Involved

- Review and provide feedback on HLDs
  - SSM HLD is available at: http://www.ieso.ca/Sector-Participants/Market-Renewal/Single-Schedule-Market-High-Level-Design
  - ERUC and DAM HLDs will be published before year end
- Participate in detailed design engagement
  - See engagement plan for further details: http://www.ieso.ca/-/media/Files/IESO/Document-Library/engage/mrp/mrp-energy-dd-engagement-plan.pdf?la=en
- Engage with appropriate industry associations to follow MRP progress
- Subscribe to IESO Bulletin to receive periodic updates on MRP

Further Reading

- For further information on the design, stakeholders are invited to review materials online at:
  - Single Schedule Market: http://www.ieso.ca/Sector-Participants/Market-Renewal/Market-Renewal-Single-Schedule-Market
  - Day-Ahead Market: http://www.ieso.ca/Sector-Participants/Market-Renewal/Market-Renewal-Day-Ahead-Market
  - Enhanced Real-Time Commitment: http://www.ieso.ca/Sector-Participants/Market-Renewal/Market-Renewal-Enhanced-Real-Time-Unit-Commitment