DER Potential Study

Stakeholder Session 3: Final Results Presentation

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In partnership with: POWER ADVISORY

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AGENDA & MEETING OBJECTIVES

1 **Recap**

- Overview of study objectives and scope

2 **Approach and Scenarios**

- Key assumptions and methods applied

3 **Summary of Results**

- Economic and Achievable Potentials

Q&A

4 **Key Takeaways & Recommendations**

- Implications and strategies for DER integration

5 **Wrap-up & Next Steps**

- Timelines and discussion

Q&A

1. Recap

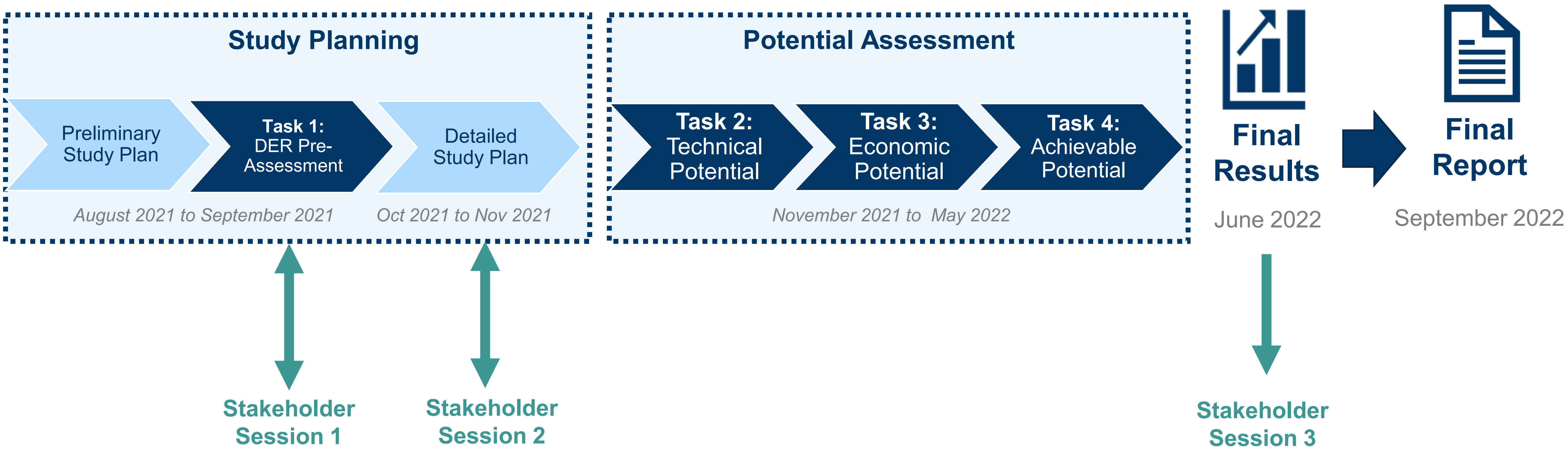
- Study Context and Objectives
- Timelines

Study Context and Objectives

- Distributed Energy Resources (DERs) have emerged as a major trend impacting the electricity grid and wholesale electricity markets, with the promise to transform the role of electricity users into active participants
- Effectively enabling DERs can provide significant benefits to the electricity grid and to consumers, and can further satisfy the preferences and priorities expressed by individuals, communities, and businesses
- This study seeks to determine the types and volumes of DERs capable of providing cost-effective electricity system services and the extent to which these DERs may emerge over a 10-year time horizon
- Insights from these results will be used to develop recommendations on focus areas, priorities, timing and key considerations for DER integration efforts in Ontario

Timelines: Overview

- **Study Planning**: August 2021 to November 2021
- **Potential Assessment:** November 2021 to May 2022
- **Final Report:** September 2022



Timelines: Stakeholder Sessions

Stakeholder Session 1: Preliminary Plan & DER Pre-Assessment (September 22nd 2021)

- Introduce project team
- Overview of the context and objectives of the study
- Share and solicit feedback on Preliminary Project Plan, DER Pre-Assessment, and to inform the development of key study parameters

Stakeholder feedback was used to refine measure list & screening criteria, prioritize scenarios, and develop detailed study plan

Stakeholder Session 2: Detailed Study Plan (November 23rd 2021)

- Present detailed study plan, highlighting methodology, key inputs and assumptions
- Solicit feedback from stakeholders on detailed project plan, and to further to inform the development of key study assumptions

Stakeholder feedback was used to further refine measure characterization of smart thermostats and to finalize scenario choices

Stakeholder Session 3: Final Results Presentation (June 22nd 2022)

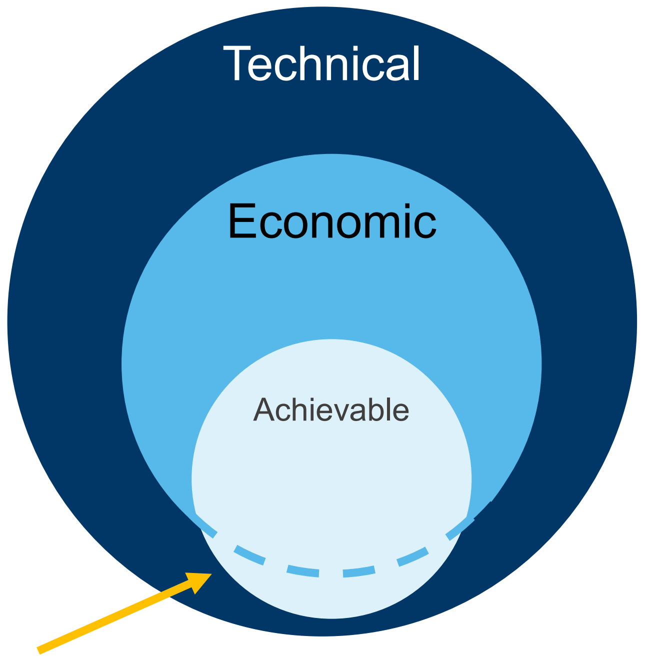
- Present final results and recommendations to stakeholders
- Solicit input on recommendations and areas for further study

2. Approach and Scenarios

Overview

The DER Potential Study analysis answers three key questions, each representing a fundamental methodological phase of the study

- **Technical Potential:** How much DER capacity theoretically exists in Ontario?
- **Economic Potential:** How much of that DER potential is cost-effective considering the benefits they bring to the system relative to their costs?
- **Achievable Potential:** How much of that potential is likely to emerge over the next decade considering IESO market dynamics, market barriers faced by customers and customer/participant-side economics (i.e. payback and payback acceptance) that drive DER adoption?



Note: Achievable potential is not exclusively a subset of economic potential – some uptake of DERs may be driven primarily by electricity customer benefits, regardless of their ability to deliver benefits to the system.

Scenarios: Overview

The Study assesses the potential under three scenarios reflecting different market, policy and technology pathways

- **BAU:** Business-as-usual reflects the existing market conditions, technology trends, and the IESO's 2021 Annual Planning Outlook (APO) Reference Case for demand
- **BAU+:** Expected system and market outlook in-line with the IESO DER Roadmap and general policy, market, and technology advances
- **Accelerated:** Accelerated efforts to support the transition to net-zero coupled with increased efforts to integrate DERs
- The scenarios were designed to provide insight into the role DERs can play under different system outlooks as well as the impact of various market interventions designed to alleviate market barriers
  - **Electrification growth rates:** the pace of transportation, building and industry electrification in Ontario over the next decade
  - **Carbon pricing:** future carbon price forecasts and allowance benchmarks
  - **Market participation and compensation:** Expanding service eligibility, access to procurements, and barrier reductions (increased market information, outreach, and support to potential DER providers)
  - **Technology Costs:** Cost reductions for key DERs stimulated by technology improvements and/or monetary support (e.g. federal grants for solar PV)
  - **Electricity supply resource mix:** Assumed additional resources projected to be deployed over the study period to meet emerging system needs

Scenarios: Assumptions

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Lever	BAU	BAU+	Accelerated
Carbon Pricing	$170/t by 2030 with 370 tCO2e/GWh benchmark	$170/t by 2030 with 0 tCO2e/GWh benchmark	$170/t by 2030 + $15/year escalation with 0 tCO2e/GWh benchmark
Electrification	APO Reference Case	APO + (in-line with APO high scenario for EVs and current federal policy direction)	APO ++ (in-line with aggressive policy push for electrification of transportation, buildings and industry)
Market Participation / Compensation	• **Service Eligibility**: Current market rules • **Capacity procurement**: Through capacity auction only • **Barriers:** Current barriers + moderate customer pass-through from aggregators (35-75%)	• **Service Eligibility**: Changes being explored by IESO + NWA Framework • **Capacity procurement**: Non-market procurement of DERs at 70% of capacity value • **Barriers:** Barrier reduction + higher pass-through from aggregators (50-80%)	• **Service Eligibility**: Expanded market participation + NWA Framework • **Capacity procurement**: Non-market procurement of DERs at 100% of capacity value • **Barriers:** Barrier reduction + higher pass-through from aggregators (75-90%)
Technology Costs	Base cost assumptions (2 – 3% annual decline)	Moderate cost decline/ financial support (3 - 5% annual decline)	High cost decline/ financial support (5 - 7% annual decline)
Supply Resource Mix	APO Forecasts	APO Forecasts + Additional non-emitting resources / storage to partially address growing supply gap	APO Forecasts + Further additional non-emitting resources / storage as per planned long-term RFP procurement (i.e., 1,000 MW of effective capacity)

3. Summary of Results

Economic Potential: Key Considerations

The economic results should be interpreted with the following considerations:

- The economic potential presents **the quantity and impact** (capacity, energy etc.) of cost-effective DERs, as measured using an advanced version of the Total Resource Cost (TRC) test typically used with IESO Conservation Demand Management guidelines. It captures the benefits from all services that DERs can reasonably contribute to, but **does not account for market adoption** or financial constraints.

- The economic potential **accounts for the system needs for different grid services under each scenario**. An annual maximum market size / service need is established for key value streams (e.g. energy, capacity, transmission/distribution deferral, Operating Reserves (OR), etc.) with adjustments for the scenarios to reflect the impacts of forecasted electrification
  - Annual maximum market size is determined based on forecasted system need by IESO and on reliability standards (e.g., Operating Reserve mandated requirements by North American Electric Reliability Corporation)

- The economic potential constrains each benefit stream to the assessed system needs, after which additional DERs derive reduced - or no - additional value

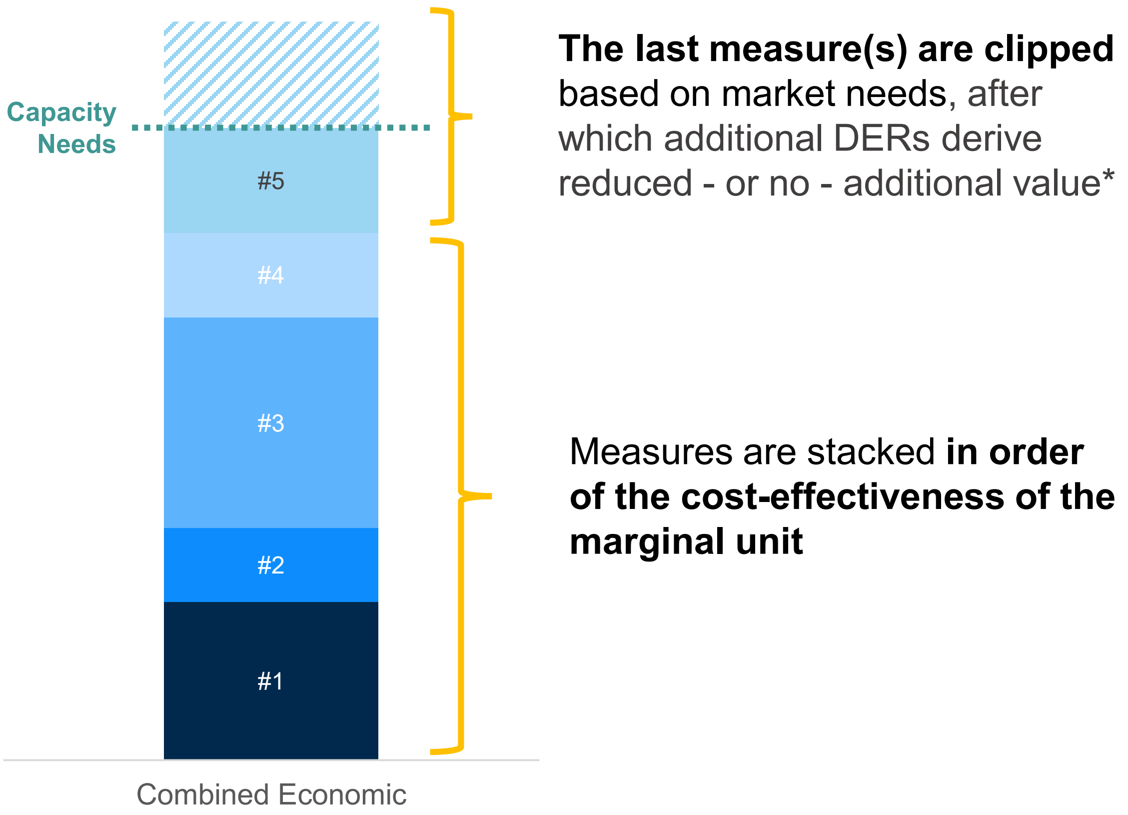
*The results presented in the slide deck are largely focused on the potential for DERs to reduce summer and winter peak capacity contribution by 2032, defined as the average reduction over a four-hour peak window. Additional metrics are highlighted in-text where relevant and will be available in the final report.

Market-Wide Economic Potential: Description

The next few slides highlight results of the Market-Wide Economic Potential:

- The metric reflects the most cost-effective mix of DER capacity capable of meeting system needs
- Based on the value/contribution of DERs to the system (i.e. not customer cost-effectiveness)
- Captures interactions and potential competition among various DERs, to avoid over-counting DER benefits or potential (i.e. FTM and BTM solar and storage)
- Does not consider market barriers and dynamics (e.g. customer adoption, market participation rules) that impact actual adoption

Illustration of the Market-Wide Economic Potential

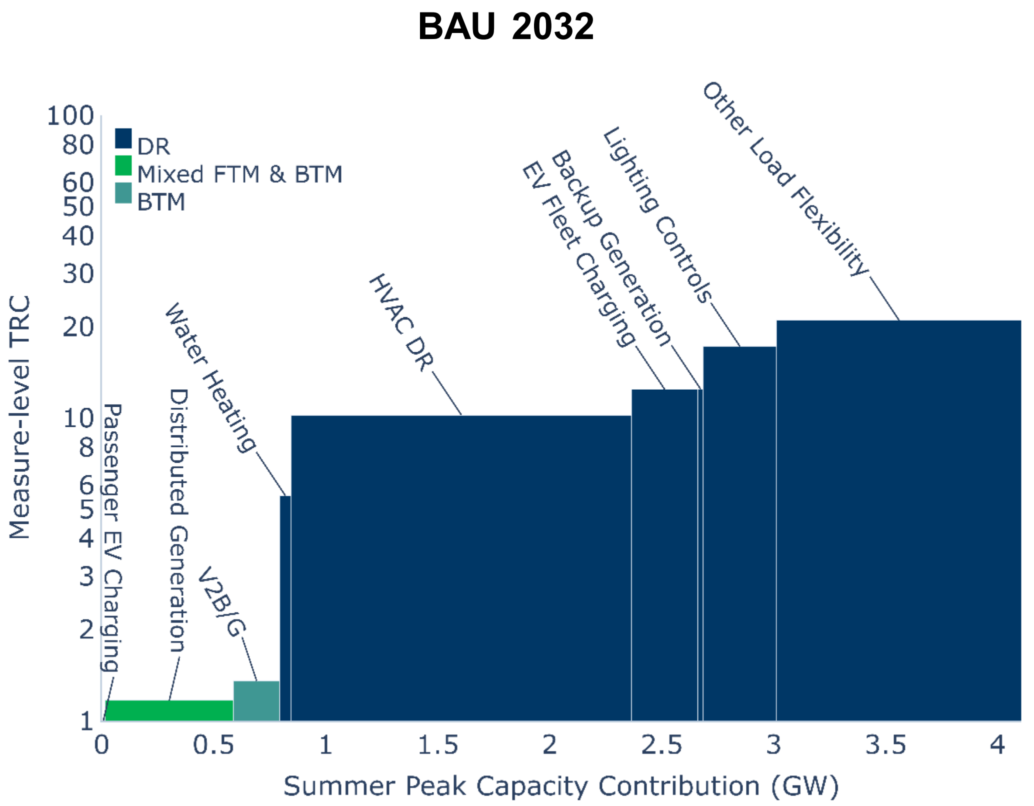


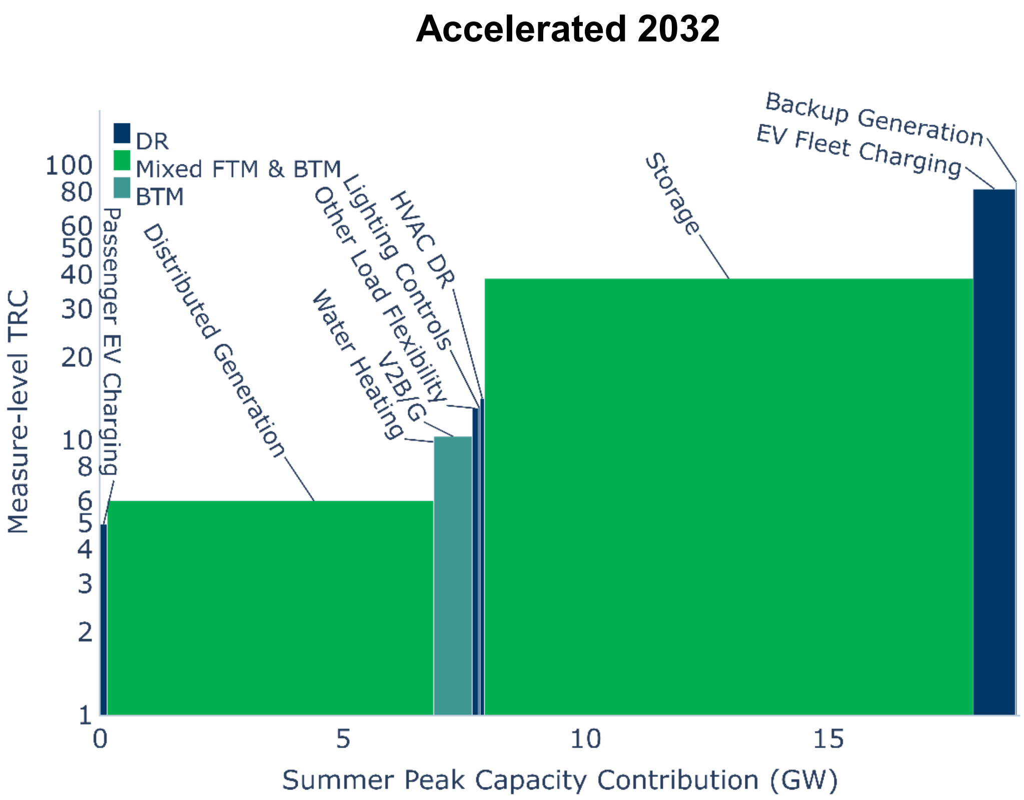
* Measures are allowed to contribute to capacity reductions beyond market needs as a by-product of contributing to another services (e.g., energy, T&D), however they receive reduced - or no - additional value from the provision of those capacity reductions

Economic Potential

TRC Values: DER Supply Curve

Market-Wide Economic Potential TRC supply curve, by measure group*





DR measures are the most cost-effective under the BAU scenario, while under the Accelerated scenario, increasing avoided costs lead to higher TRCs across the board, and BTM/FTM DERs become significantly more cost-effective, than under the BAU.

** The BAU+ scenario TRC results are not shown here but are very similar to those shown for the BAU scenario, including some storage.*

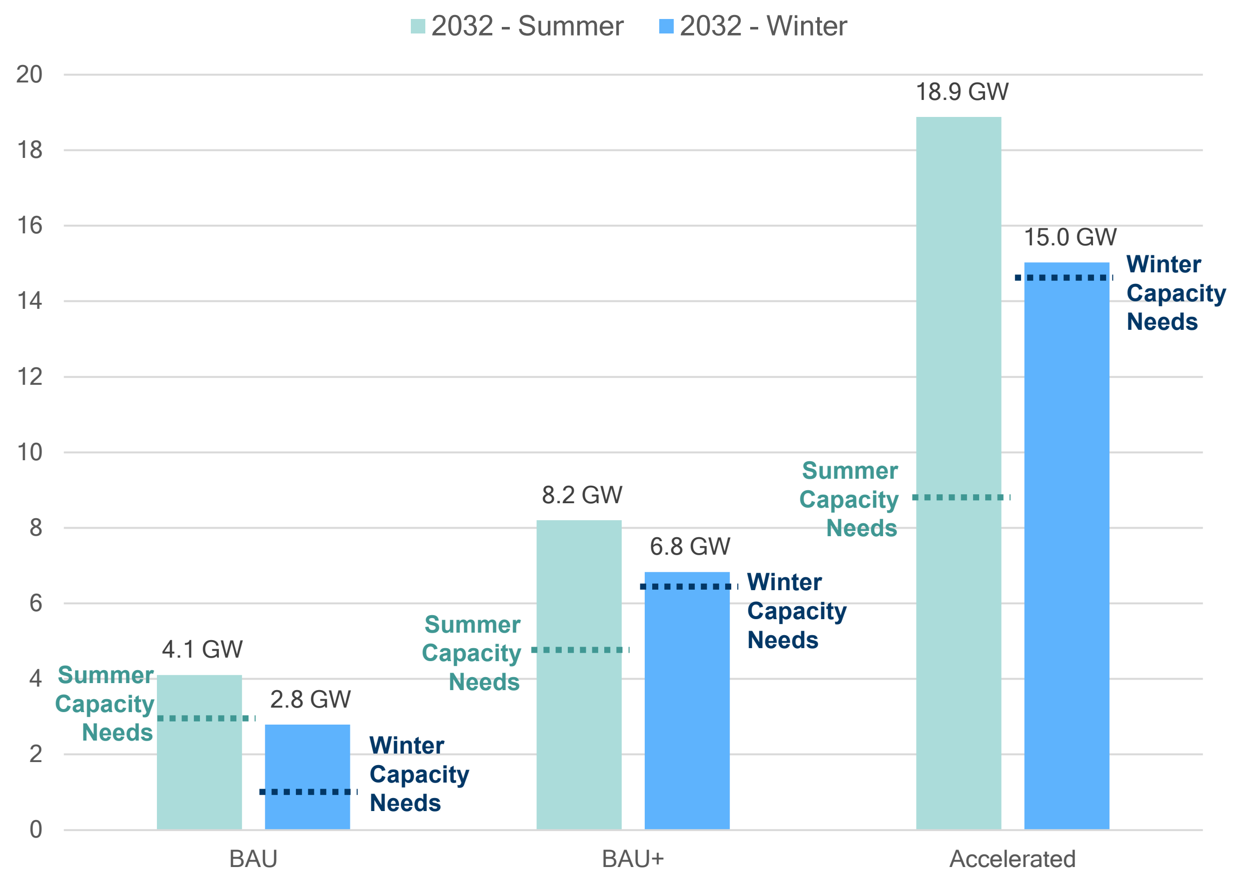
Market-Wide Economic Potential: Seasonal Peak

DERs can also cost-effectively meet a large portion of emerging seasonal peak needs

- **Under all scenarios** there is sufficient cost-effective DER potential to meet Ontario's summer and winter additional capacity needs in 2032
- There is significantly **more excess DER economic potential to meet summer peaks than in winter,** as some key DERs offer less winter capacity benefits (i.e. Solar PV, and HVAC DR)
- However, this **does not account for customer/participant adoption**, which impacts the achievable DER potential (shown later).

Note: *Capacity reductions exceed the defined system capacity needs due to some measures providing further capacity reductions as a byproduct of addressing another system needs (e.g. winter capacity needs, energy or T&D)*

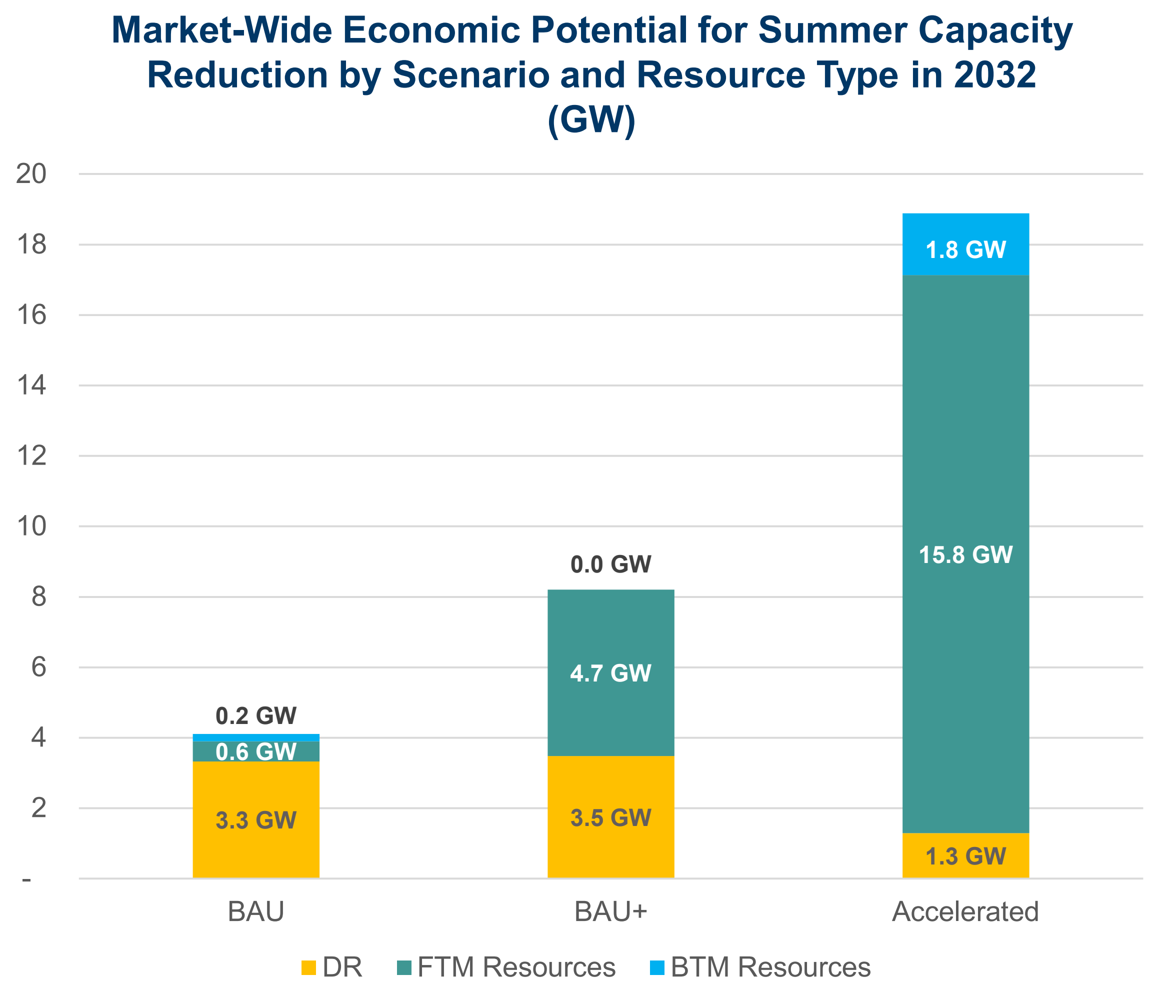
Market-Wide Economic Potential for Capacity Reduction by Scenario and in 2032 (GW)



Market-Wide Economic Potential: Resource Types

The economic portfolio of DERs that can meet capacity needs:

- **BAU Scenario:** A mix of cost-effective DR and BTM opportunities along with FTM solar provide 4.1 GW of peak demand reductions.
- **BAU+ Scenario:** Reduced installed costs coupled with higher carbon pricing and increased energy costs (driven by increased demand) enable an additional 4.1 GW of capacity reductions from FTM solar & storage.
- **Accelerated Scenario:** DR contributions are diminished by more cost-effective FTM storage opportunities. BTM storage and solar resources begin to emerge in the stack to address growing energy needs.



Achievable Potential: Key Considerations

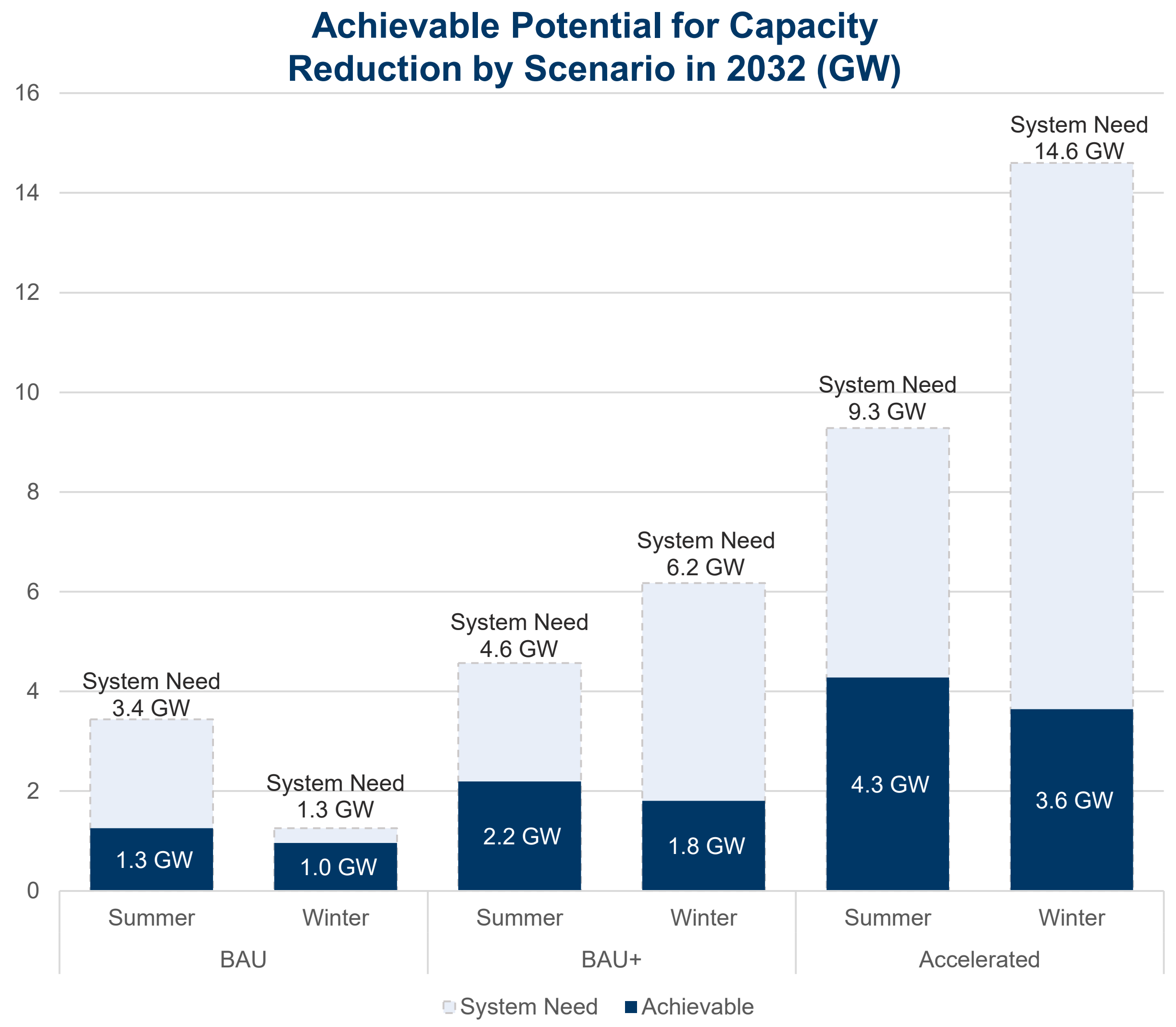
The achievable results should be interpreted with the following considerations:

- The achievable potential **considers market dynamics and barriers that impact the adoption and participation of DERs**, to provide three key insights:
  - How do customer economics, market participation rules, etc. impact the potential uptake of DERs?
  - What portion of the economic potential can actually be achieved over the next 10 years?
  - How does the mix of expected DER capacity differ from the "most cost-effective" pathways highlighted through the Market-Wide Economic Potential?
- The assessment applies specific **Participation Pathways** to determine the achievable potential:
  - BTM distributed generation resources are assumed to participate primarily through net-metering
  - DR measures and BTM storage are modeled as aggregated market resources with the assumption that aggregators would provide customers with a participation / performance incentive equivalent to a portion of the market revenues [varied by scenario]
  - FTM resources were assumed to participate in the market directly

Summary: Capacity Reductions by 2032

Under the achievable scenarios, DERs can contribute to 25%-80% of Ontario's additional capacity needs over the next decade

- **BAU Scenario:** 7.4 GW of DERs (nameplate capacity) contribute to 1.0 - 1.3 GW of peak reductions by 2032 (equivalent to a 4%-5% reduction in system peak)
- **BAU+ Scenario:** 13.2 GW of DERs (nameplate capacity) contribute to 1.8 - 2.2 GW of peak reductions by 2032 (equivalent to a 6%-7% reduction in system peak)
- **Accelerated Scenario:** 25.4 GW of DERs (nameplate capacity) contribute to 3.6 - 4.3 GW of peak reductions by 2032 (equivalent to 9%-14% reduction in peak)

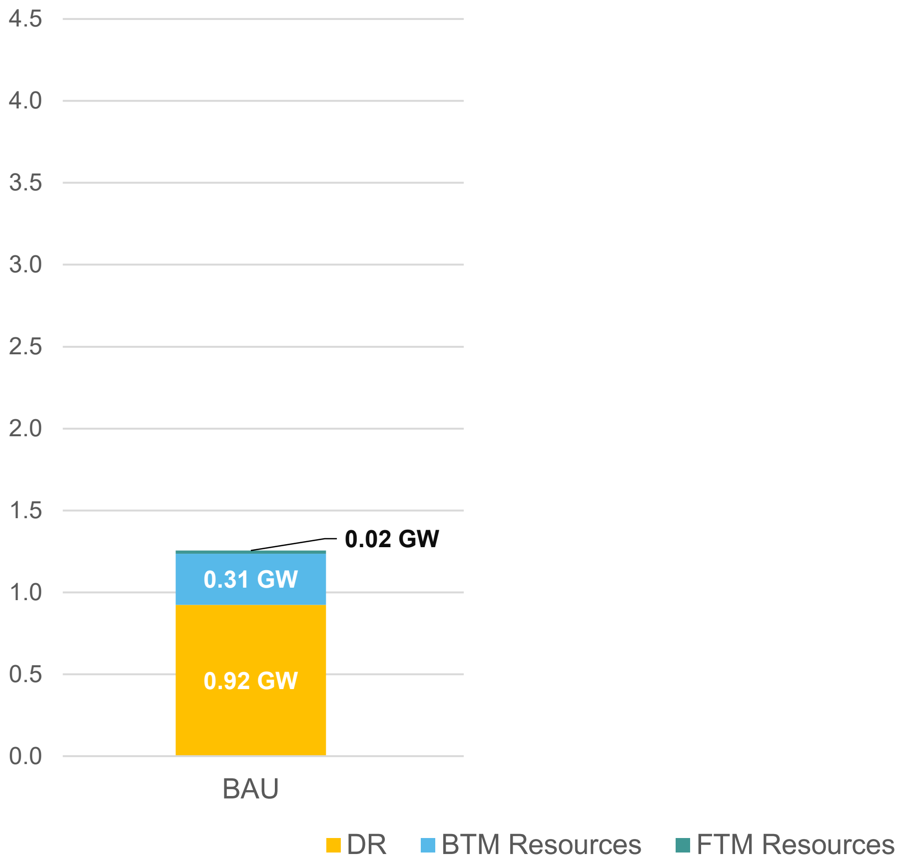


Summary: BAU

The mix of DERs forecasted in the achievable scenarios diverge from that observed in the Economic Potential:

- **Under BAU, the majority of the achievable potential comes from DR** opportunities, however the potential is limited by the low market revenues / participation incentives available to customers
- Despite the significant economic potential, **very limited FTM capacity emerges under BAU** due to an assumption that the capacity auction would be the sole procurement mechanism for capacity and due to the absence of T&D revenue streams
- Despite lower cost-effectiveness from a system perspective and the relatively low energy market prices under the BAU, **BTM resources do appear in the achievable mix of DERs** as a result of enabling programs (e.g. net-metering, ICI) and non-financial drivers (e.g. resiliency, environmental benefits) that offer a value proposition to adopting customers

Achievable Potential for Summer Capacity Reduction by Scenario and Resource Type in 2032 (GW)

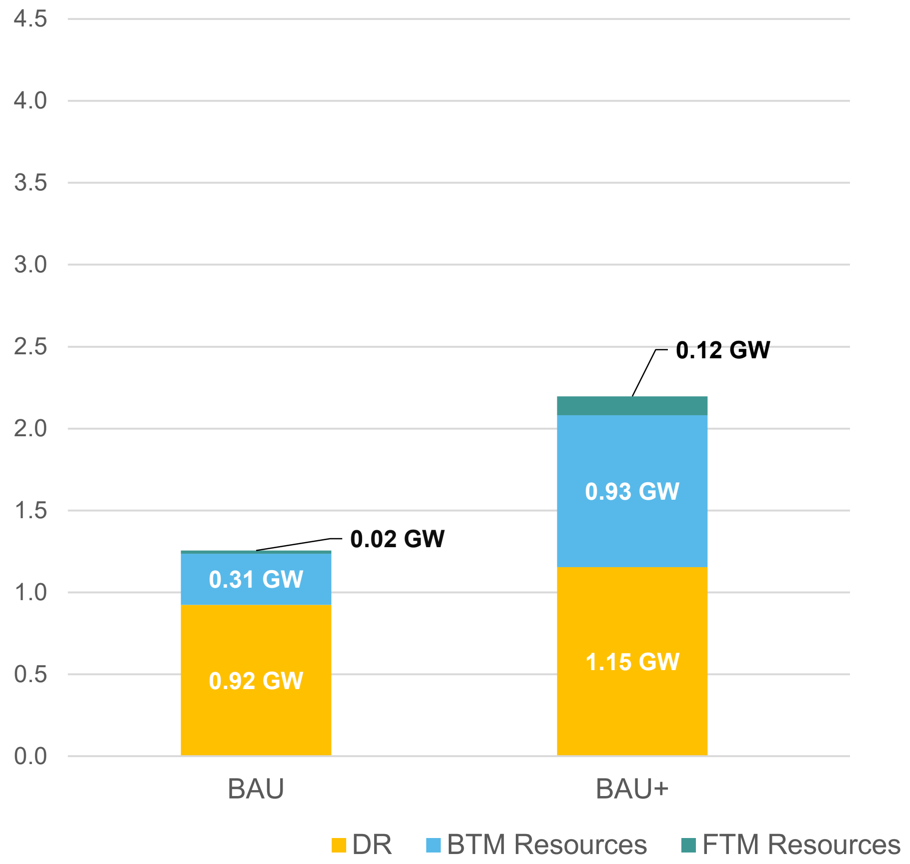


Summary: BAU+

Under BAU+, increased market revenues and capital cost reductions result in 900 MW of additional summer peak reductions

- 230 MW of additional peak reductions from DR, mostly driven by growth in EV opportunities (fleet and passenger smart charging and light-duty vehicle telematics)
- Highest growth observed in BTM Resources, with increased uptake of solar, storage and Vehicle-to-Building (V2B) and Vehicle-to-Grid (V2G) measures
- Modest increase in FTM capacity resources (battery storage and solar)

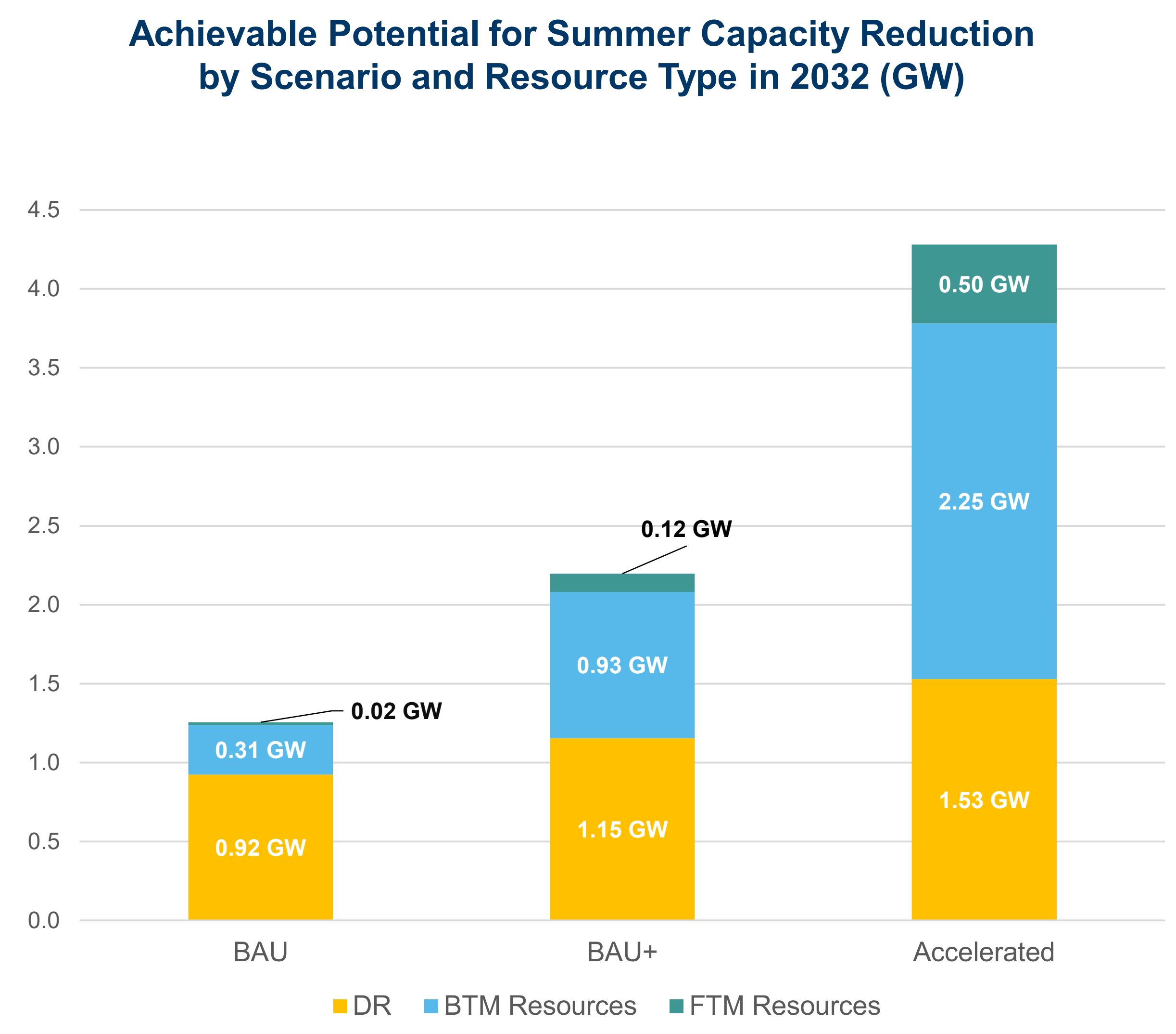
Achievable Potential for Summer Capacity Reduction by Scenario and Resource Type in 2032 (GW)



Summary: Accelerated

In the Accelerated Scenario, summer peak reductions from DERs doubles to 4.4 GW relative to BAU+

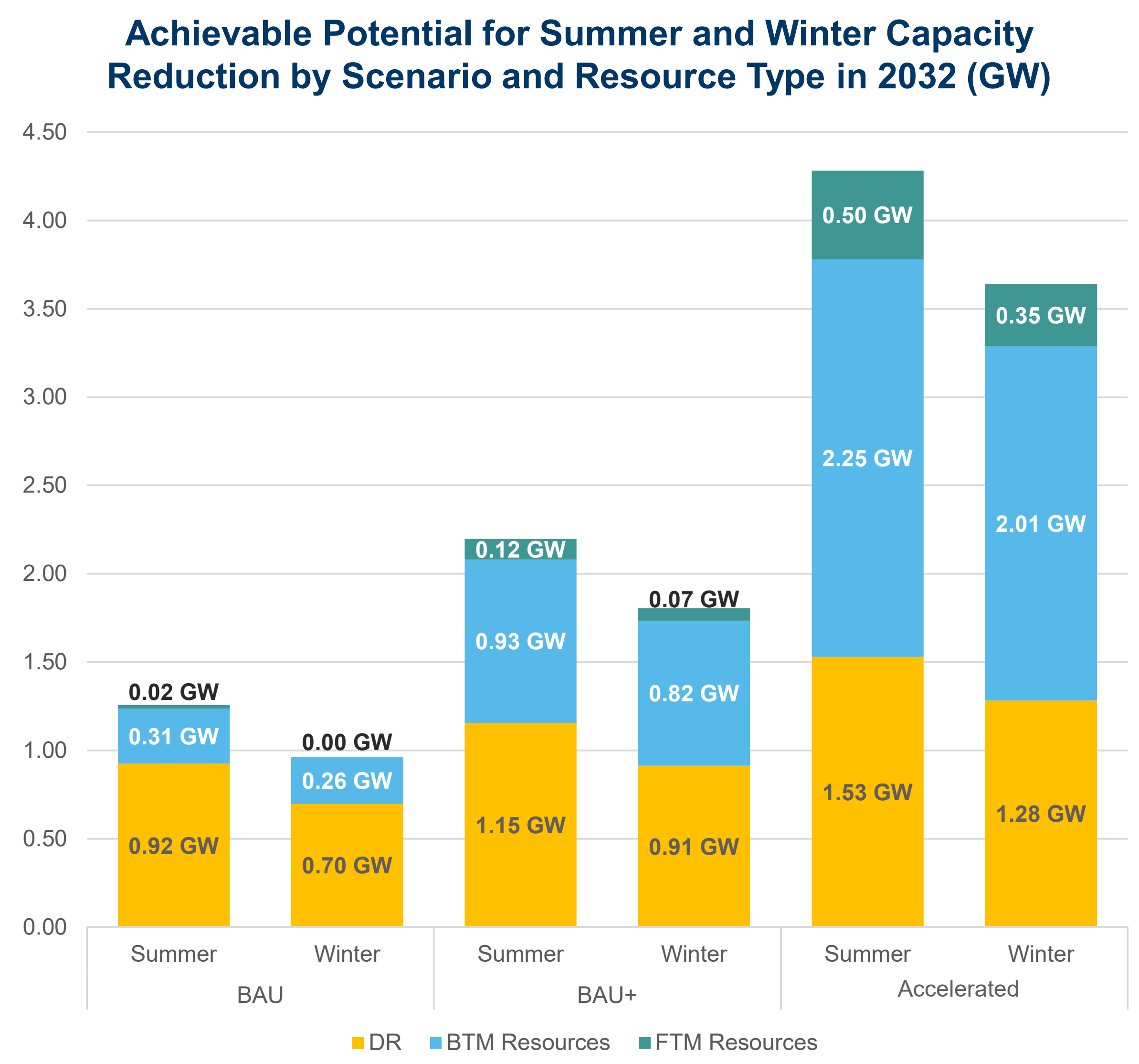
- **380 MW of additional peak reductions from DR**, mostly driven by high growth in EV opportunities
- **Highest growth observed in BTM Resources**, with increased uptake of solar, storage and V2B/G measures
- **Equipment cost reductions and increased revenues** support the development of additional FTM battery storage, hydro, and solar capacity, and results in an additional 370 MW of peak reductions
- **FTM resources become highly cost-effective toward the end of the study in the Accelerated scenario**, but time lags and investor hurdle rates continue to hinder the achievable potential



Summary: Winter Peak Reductions

In general, the contributions of the forecasted resources are lower in the winter than in the summer

- Capacity contribution of solar drops to near 0
- Drop in HVAC DR potential due to limited penetration of electric space heating (shrinking delta with increased electrification under BAU+ and Accelerated)
- Lower coincidence for some measures / loads with winter peak window (e.g. large commercial HVAC, AC thermostats, solar)
- Higher contribution of EV measures (e.g. smart charging, telemetry, and V2B/G)

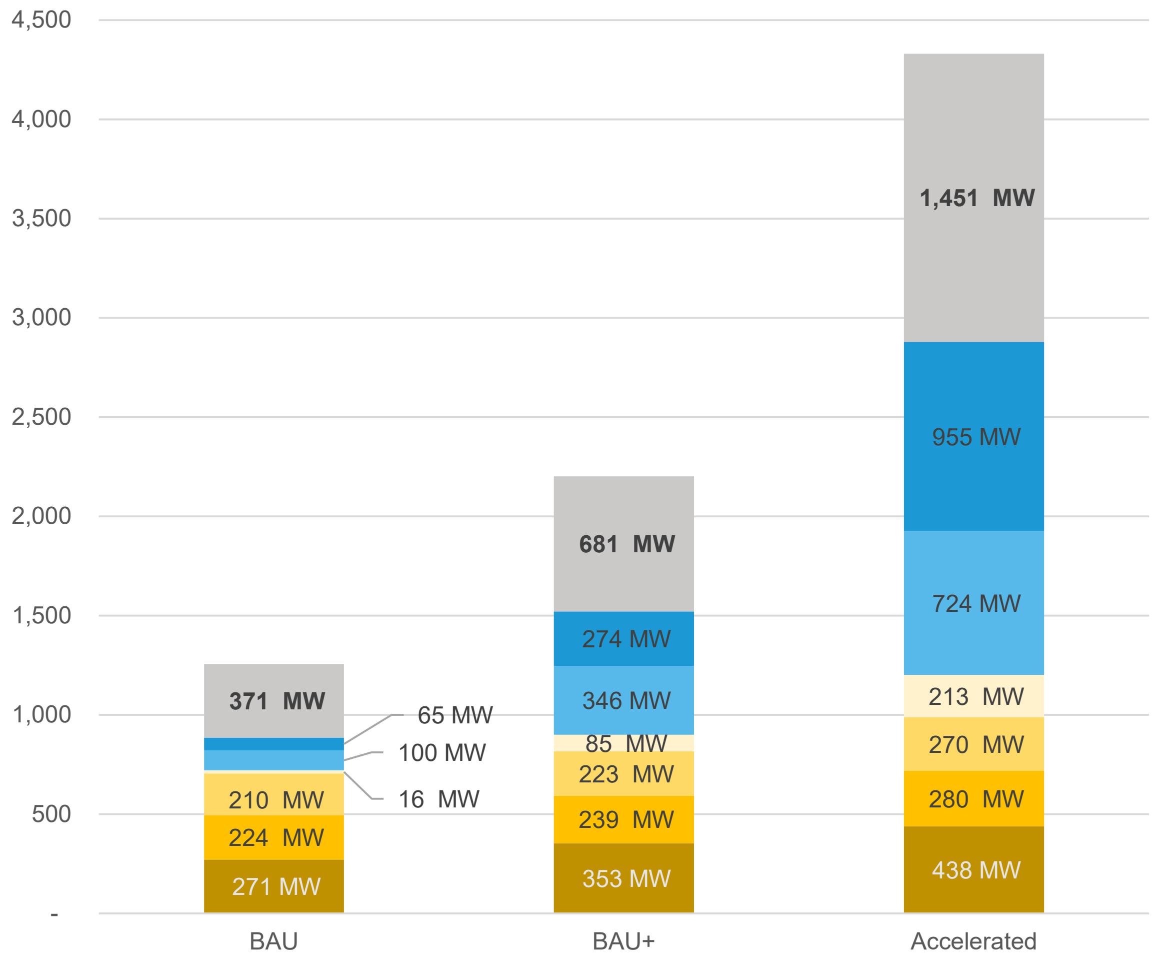


Summary: Top Measures

Despite the diversity of DERs that show potential, six key DER opportunity areas represent nearly 70% of the achievable peak capacity contributions over the next decade

- While Solar PV does not show up as a top six measure from a system capacity perspective, its energy contributions lead to significant solar achievable potential (4.8 GW – 26.3 GW of nameplate capacity)

Achievable Potential for Capacity Reduction by Measure by Scenario in 2032 (MW)



- Residential AC Thermostat
- Large Commercial HVAC Control
- Commercial Load Flexibility
- Passenger EV Smart Charging
- Non-Residential BTM Storage
- Residential V2B/G
- Other

Commercial Load Flexibility is all opportunities other than HVAC DR.
Other represents all other DER measures not listed above.

Q&A Break 1

4. Key Takeaways & Recommendations

Key Takeaways (1/2)

- **There is sufficient economic potential for DERs to cost-effectively meet Ontario's projected capacity deficits over the next decade.** The results highlight that under the BAU scenario, the total economic potential for DERs exceeds Ontario's forecasted summer capacity deficits over the next decade.

- **The modeled market, policy and technology changes under the BAU+ and Accelerated scenarios can increase achievable potential for DERs, thereby supplying more of the incremental capacity needs.** The higher levels of electrification under the BAU+ and Accelerated scenarios create new opportunities and needs for leveraging controllable loads in the residential, commercial, and industrial sectors.

Summary of DER potential by Scenario - Capacity

Seasonal Capacity	Potential	BAU	BAU+	Accelerated
Summer 2032	**Incremental System Needs**	**2.6 GW**	**5.6 GW**	**6.9 GW**
	Economic Potential	4.1 GW (15% of peak demand)	8.2 GW (27% of peak demand)	18.9 GW (61% of peak demand)
	Achievable Potential	1.3 GW (5% of peak demand)	2.2 GW (7% of peak demand)	4.3 GW (14% of peak demand)
Winter 2032	**Incremental System Needs**	**0.9 GW**	**6.4 GW**	**13.3 GW**
	Economic Potential	2.8 GW (11% of peak demand)	6.8 GW (22% of peak demand)	15 GW (40% of peak demand)
	Achievable Potential	1.0 GW (4% of peak demand)	1.8 GW (6% of peak demand)	3.6 GW (9% of peak demand)

Key Takeaways (2/2)

Despite the large economic potential, less than a third of the economic potential is achievable over the next decade under existing market conditions and compensation mechanisms. In some cases, DERs may not receive full compensation for all the system benefits they offer, such as capacity and T-D avoidance and deferral. Increasing access to all value streams for DERs is expected to raise the achievable potentials, but in many cases customer economics and barriers would continue to hinder uptake such that the achievable potential will remain significantly lower than the Economic Potential. This may be particularly impactful for FTM DERs that show high economic potential, but relatively low achievable potential.

A handful of DERs are expected to contribute the vast majority of the achievable potential, and thus efforts should focus on maximizing the uptake and participation of these DERs.

- Conventional large commercial and industrial DR opportunities currently represent the majority of DR participation in the capacity auction, and are expected to grow over the next decade.
- Residential HVAC DR, EV smart charging and V2B/V2G, BTM energy storage and BTM solar are also forecasted to make up increasing portions of potential across all scenarios.
- Near-term focus should be on expanding residential DR capabilities (AC & HP thermostats and EVs) as they offer significant cost-effective potential. IESO is already leveraging non-residential DR (large C&I HVAC & flexibility and Non-Residential BTM Storage) through the Capacity Auction. In the long run, new measures like V2B/G, residential BTM storage, FTM solar and FTM storage could emerge as significant growth opportunities.

Recommendations

Based on key findings and insights from the potential assessment, the project team developed recommendations to inform the IESO's ongoing efforts to integrate DERs, as identified in the DER Roadmap. Primarily, the team identified the need for initiatives to support the enablement of DERs.

Primary Recommendation → Further Considerations

Enabling DERs

Initiatives to unlock the identified potential for DERs by expanding participation pathways

Coordinating on DERs

Broader coordination efforts needed to support the efficient integration of DERs in Ontario

Integrating DERs

Supporting activities needed to prepare the electricity system for the role of DERs

Recommendations: Enabling DERs (1/2)

- **Continue with the DER Market Design Vision and Design Project:** The changes being considered by the DER Market Design Vision would bring Ontario closer to alignment with other North American jurisdictions subject to FERC Order 2222. This would also reduce barriers to DER market participation and unlock larger portions of the identified economic potential for DERs. The foundational elements of DER Market Design will be in place by Q2 2026, following IESO's DER Roadmap.

- **Develop Tailored DER Procurement and Program Initiatives:** The IESO should pursue initiatives to target high-potential and cost-effective DERs in the near-term to support meeting emerging resource adequacy needs in 2025, further focusing on measures and sectors where market pathways are unavailable or insufficient.

Example of Tailored DER Initiatives

Given the significant potential for HVAC DR identified in the study, a specific program could be developed to capture cost-effective peak load management measures related to residential HVAC systems - measures that may not be participating effectively under the current Hourly Demand Response (HDR) participation model of the IESO's Capacity Auction.

Recommendations: Enabling DERs (2/2)

- **Develop T&D Compensation Frameworks**: DERs can cost-effectively help meet Transmission and Distribution needs and thus they should be compensated for this value stream to ensure the system can benefit from the services DERs can provide, which is consistent with the IESO DER Roadmap and its emphasis on Non-Wires Alternatives.

- **Align Telemetry and Metering Requirements with Expected Resource Contribution:** The IESO should adopt telemetry requirements that are tailored to the expected service provision, the magnitude of contributions and capabilities of different resources and aggregations of resources.

High-economic value DERs - key findings and recommended participation pathways

Term	Resource Group	Findings / Recommendations
Near-term	Residential HVAC DR	**High near-term potential, but unlikely to be tapped into with existing market** / procurement mechanism. Can be enabled through a program (IESO or LDC-led) or dynamic rates (e.g. CPP) and direct load control (DLC).
	EV	**EVs (Residential and Fleets) have a sizeable near-term potential, but it's unlikely to be tapped into with existing market** / procurement mechanism. IESO should consider pilot programs and explore partnerships with other aggregators (e.g. third parties, LDCs). Can be enabled through a program (IESO or LDC-led) or dynamic rates (e.g. CPP) and DLC.
Long-term	V2B/G	Long-term development of the EV market is uncertain, but **V2B/G and telemetry-based smart charging are emerging technologies**. IESO should prepare for the emergence of these technologies using pilots and making sure these technologies have clear participation pathways.
	Solar and Storage	Given the high TRCs and economic potential under some scenarios, **the IESO could develop targeted procurements to enable FTM and BTM solar and / or storage uptake.**

Considerations: Coordinating on and Integrating DERs

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Coordinating on DERs

- **Contribute to a coordinated DER framework**: IESO should continue to actively engage with stakeholders from government, OEB, and LDCs for alignment and coordination of DERs.
- **Inform policy discussions**: IESO should play an active role in monitoring and informing discussions on key issues such as electrification, the efficient pricing of carbon, and other key levers that impact system needs and DER potential.
- **Engage in pilots and demonstration projects for emerging DERs**: Many DERs are emerging technologies (e.g. V2B/G) or have not been demonstrated at a large scale in Ontario to date (e.g. residential smart thermostat controls). For example, with the shift to winter-peaking conditions under the BAU+ and Accelerated scenarios, the IESO could consider piloting a residential electric heating DR and/or a thermal storage program.

Integrating DERs

- **Invest in DER data collection and information sharing systems**: IESO will need to increase visibility of DERs to better estimate market size and impact.
- **Expand advanced planning capabilities and coordination**: Forecasting the uptake and impacts of DERs will need to become a central part of IESO's planning processes as DER penetration increases.
- **Investigate and adopt new methods and processes to manage DERs**: IESO should assess the impacts of DERs on grid operation protocols and investigate the need for new methods, processes, and tools to manage system impacts.

Q&A Break 2

5. Wrap-Up and Next Steps

- Requested Input/Feedback from Stakeholders
- Next Steps

Next Steps and Stakeholder Feedback

- **The IESO will publish the complete report in July on the IESO web page**
  - Stakeholders will be given 4 weeks following publication of the full report to review and provide feedback
- **The IESO is seeking stakeholder feedback on the following topics**
  - Does the report highlight the most relevant key takeaways? If not, what other results are of high importance?
  - Do the recommendations identify appropriate steps to enable the DER potential revealed in the study? Based on the study results, are there other actions that should be considered?
  - Building on the work completed in this study, are there other areas of analysis that should be considered to provide meaningful insight for the IESO and others in the sector?

Thank You

Questions or feedback can be directed to: engagement@ieso.ca

Materials relating to this project, including this presentation and feedback questionnaire, are available at the IESO DER Potential Study engagement page at the link below: https://www.ieso.ca/en/Sector-Participants/Engagement-Initiatives/Engagements/DER-Potential-Study

Appendix

System Needs

The study is focused on identifying the potential for DERs to contribute to different grid services and address emerging system needs in Ontario.

- For each service, projected system needs for each year in the study period are estimated to **represent the maximum potential contributions for DERs,** after which the value of incremental contributions is 0.
- The projected system needs for BAU+ and Accelerated are based on adjustments to current system needs to reflect the impacts of the forecasted load growth from electrification assumed under the two scenarios

	Total Market Opportunity in 2032		
Service / Value Stream	**BAU**	**BAU+**	**Accelerated**
System Capacity (MW)	3,400 MW (Summer) 1,300 MW (Winter)	4,600 MW (Summer) 6,200 MW (Winter)	9,300 MW (Summer) 14,600 MW (Winter)
Energy (TWh)	32 TWh	39 TWh	88 TWh
Surplus Baseload Generation (SBG)	5 GWh (down from 110 GWh in 2022)	0 GWh (down from 61 GWh in 2022)	0 GWh (down from 61 GWh in 2022)
Operating Reserves	200 MW (10-min spinning), 620 MW (10-min non-spinning), 410 MW (30-minute)		
Regulation Capacity	150 MW		
Transmission Capacity Deferral*	2,400 MW	2,740 MW	4,140 MW
Distribution Capacity Deferral*	290 MW	620 MW	960 MW

*Given the province-wide nature of this study, we make the simplifying assumption that DERs that receive the T&D benefits are targeted in the specific regions where the T&D needs emerge. The T&D benefits are capped at the T&D system needs identified under each scenario.

Promising DERs: Residential BTM Resources (1/2)

Measures that passed qualitative screening:

Measure Group	Measure
Distributed generation	BTM solar with smart inverter
HVAC	AC Thermostat Dual-fuel Space Heating (With And Without Smart Switch) ASHP/DMSHP Smart Thermostat Electric Furnace Smart Thermostat* Electric Baseboards Smart Thermostat*
Other load flexibility	Other Behavioural-based Flexibility
Passenger EV charging	Smart EV chargers EV Telematics V2B/G

** Added at a later point in the study after identifying a potential shift to a winter peak in the BAU+ and Accelerated scenarios.*

Measure Group	Measure
Pools and spas	Pool Pump
Smart appliances	Smart Clothes Dryer
Storage	BTM Battery Storage
Thermal storage	Thermal Storage for Cooling Thermal Storage for Heating Thermal Storage and HP
Water heating	HP Water Heater with Smart Switch Resistance Water Heater with Smart Switch Smart Resistance Water Heater Smart HP Water Heater

Promising DERs: Residential BTM Resources (2/2)

Examples of measures that did not pass qualitative screening

Measure Group	Measure	Rationale
Passenger EV charging	EV Charger with Smart Switch	Prevalence of smart charging as well as in-vehicle charging capabilities likely to limit market for non-smart EV chargers
Pools and spas	Resistance Pool Heaters	Limited market opportunity given the small market size
Pools and spas	Hot Tub/Spa	Limited ability to contribute to system needs & low opportunity size
Smart appliances	Clothes Dryer Smart Switch	Measure typically not found to be cost-effective
Smart appliances	Smart Fridge/Freezer	Measure typically not found to be cost-effective

Promising DERs: Non-Residential BTM Resources (1/2)

Measures that passed qualitative screening:

Measure Group	Measure
Distributed generation	Back-up Generation Commercial BTM Solar Industrial BTM Solar
Lighting controls	Lighting controls
EV fleet charging	LDV Fleet EV Smart Chargers LDV Fleet V2B/G MDV Fleet EV Smart Chargers MDV Fleet V2B/G HDV Fleet EV Smart Chargers HDV Fleet V2B/G Buses EV Smart Chargers Buses V2B/G

Measure Group	Measure
HVAC	Large C&I HVAC Control Small C&I Smart Thermostat Small C&I ASHP/DMSHP Smart Thermostat
Other load flexibility	District Cooling/Heating Flexibility Industrial Flexibility Commercial Load Flexibility Irrigation Pump Controls Refrigeration Controls Greenhouses: Grow Lights Controls
Storage	BTM Battery Storage
Thermal storage	Commercial HVAC Thermal Storage Thermal Storage for Refrigeration Applications
Water heating	Large C&I Dual-Fuel Water Heating Large C&I Hot Water Small C&I Hot Water

Promising DERs: Non-Residential BTM Resources (2/2)

Examples of measures that did not pass qualitative screening

Measure Group	Measure	Rationale
Distributed generation	Biomass/Biogas	Offers mid-level benefits, with low market opportunities & cost-effectiveness
Distributed generation	CHP	Limited range of grid services, low cost-effectiveness, and high GHG impacts
Storage	Short-duration Storage (flywheel, Capacitor Bank, etc.)	Expensive technology and limited applicability (regulation)
Water heating	Small C&I Dual-Fuel Water Heating	Limited market opportunity and GHG reductions
Distributed generation	Natural Gas Fuel Cell	Limited market opportunity and GHG reductions
Pools and spas	Pool Pumps	Limited ability to contribute to system needs

Promising DERs: FTM Resources (1/2)

Measures that passed qualitative screening:

Measure Group	Measure
Distributed generation	FTM Solar FTM Small-scale Hydro

Measure Group	Measure
Storage	FTM Battery Storage

Promising DERs: FTM Resources (2/2)

Examples of measures that did not pass qualitative screening

Measure Group	Measure	Rationale
Distributed generation	FTM Biomass/Biogas	Limited expected cost-effectiveness and market opportunities given the competition for biomass feedstock
Distributed generation	FTM Small-scale Wind	Limited market opportunity given the small market size
Storage	CAES	Typically deployed as larger transmission connected assets to leverage economies for scale
Storage	Power-to-Gas (Hydrogen)	Limited market readiness and not expected to be commercially mature by the end of the study period
Storage	Flywheel	Limited ability to contribute to system needs and minimal cost-effectiveness compared to other storage measures
Storage	Electrothermal Storage	Typically deployed as larger transmission connected assets to leverage economies for scale

Economic Potential: Benefit-Cost Framework (1/3)

Benefit-Cost Framework

- **A modified Total Resource Cost (TRC) test to be used to assess cost-effectiveness**
  - Assess cost-effectiveness of DERs from the perspective of the system
  - Consistent with the framework the IESO uses for its Energy Efficiency APS
  - Primer on TRC included in the appendix
- **Determine the appropriate benefit and cost streams**
  - **Benefits:** The value DERs contribute to the system defined as the corresponding avoided grid services (quantified using market proxies where relevant)
  - **Costs:** The incremental costs of securing the DER capacity for the identified service provision
- **Quantify the benefits (i.e. avoided costs) and cost streams; as described in the upcoming slides.**
  - Avoided costs to be update for each scenario as needed to reflect modeled market and system outlooks

Benefits

A. Avoided energy costs (carbon costs embedded)
B. Avoided surplus baseload generation (SBG)
C. Avoided generation capacity costs
D. Avoided operating reserves (OR) [10-minute spinning, 10-minute non-spinning, 30-minute spinning]
E. Avoided regulation capacity (RC)
F. Avoided / deferred transmission capacity costs
G. Avoided / deferred distribution capacity costs
H. Avoided transmission and distribution line losses

Costs

A. Measure costs
B. Measure O&M costs
C. Program, aggregation and/or transaction costs

Economic Potential: Benefit-Cost Framework (2/3)

Approach to Quantifying Benefits and Costs

	Benefit / Cost	Methodology	Key Inputs
A	**Energy**	• Derived from Power Advisory proprietary hourly dispatch model for Ontario; • Demand is based on historical load shapes, forecasted peak demand from IESO APO and load shape manipulators for future impacts (e.g., EVs, heat pumps, industry load) • Offer data is based on Power Advisory market intelligence, rate filings, and publicly available data; planned and unplanned outages for all resource types • Commodity costs have carbon pricing and emissions performance standard rules incorporated	• Weather dependent hourly profile data for supply and demand • Future system needs as per IESO planning outlooks • Forward commodity markets
B	**Surplus Baseload Generation**	• SBG identified by zero or negative pricing hours forecasted by PA's real-time energy model • SBG cost based on information published by IESO for SBG payments; future value determined by escalation of foregone energy & SBG deferral account costs	• Forgone energy payments and SBG deferral payments by asset type
C	**Capacity**	• Based on resource requirement expectations forecasted by IESO through APO • Future resource developments that impacts resource requirements over planning horizon • Development of supply costs under multiple timelines (i.e., short-term, mid-term, and long-term)	• Resource requirement • Historic supply costs • Projected technology costs
D	**Operating Reserves**	• Statistical relationship to hourly real-time energy price forecast with adjustments for supply constraints and technology advancements	• Historic OR & HOEP prices • Future supply/demand balance • Projected technology costs
E	**Regulation Capacity**	• Based on potential future Regulation Capacity identified by the IESO • Value based on grid-scale resource costs	• Historic RC prices in Ontario and neighbouring jurisdictions

Economic Potential: Benefit-Cost Framework (3/3)

Approach to Quantifying Benefits and Costs

	Benefit / Cost	Methodology	Key Inputs
F	**Transmission Costs**	• Identification of transmission system investments to meet bulk & regional power system needs, considering forecasted electrification load growth • Deferment potential based on typical transmission capacity investments	• Regional Planning documents • Typical transmission expansion costs
G	**T&D Line losses**	• Line losses are captured as Line Losses Adjustment Factor on distribution bills; with seasonal adjustments factors as available	• Line Losses Adjustment Factor
H	**Distribution Costs**	• Forecast of system service spending by Local Distribution Companies and estimate of portion of system service used for distribution capacity expansion • Consideration of the impacts of forecasted electrification load growth	• Historic and forecasted system service spending
A	**Measure Costs**	• For measures where uptake is driven by participation, includes the incremental cost or full cost of measure	• Market intelligence on measure costs
B	**Measure O&M Costs**	• For measures where uptake is driven by factors outside of participation, little to no O&M costs applied • For measures where uptake is driven by participation, the full O&M cost is applied	• Market intelligence on O&M costs
C	**Program, aggregation and/or transaction costs**	Typical administration, marketing, resource acquisition and other costs needed to enable DER participation in markets	Based on Dunsky's Program Archetype Library and complemented with research and insights from Ontario and other jurisdictions with similar market structures