IESO Market Renewal Project

Preliminary Indicative Benefits Case Analysis

PRESENTED TO

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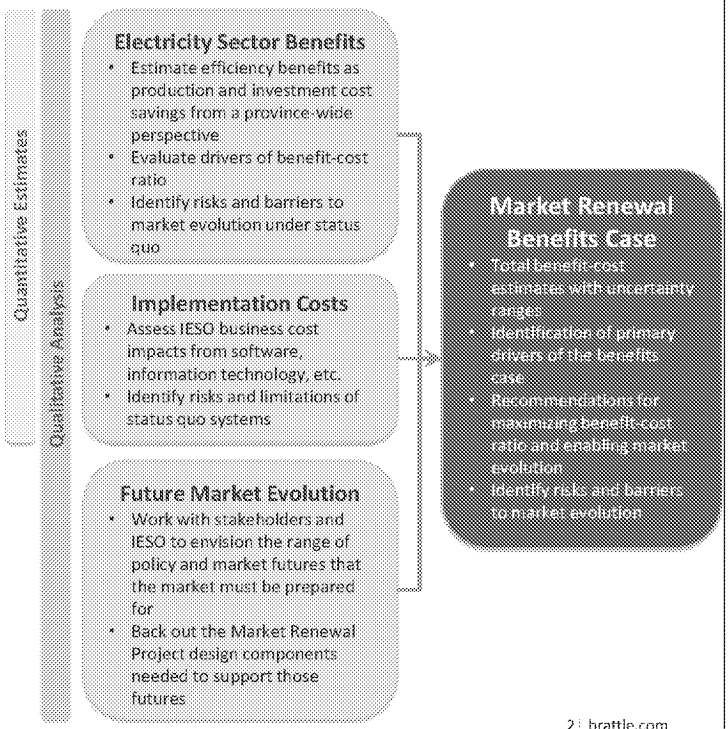
Agenda

- **Overview**
- **Sector Benefits**
  - Energy
  - Operability
  - Capacity
  - Accounting for Contracts
- **Implementation Costs**
- **Preliminary Findings**
- **Next Steps**

Overview

Overview of Market Renewal Benefits Case

- Ontario's electricity market was designed for a very different time and fleet mix
- Market renewal will:
  - Address inefficiencies with the existing design, achieving "Market Design 2.0" Benefits
  - Position the sector to operate in a very different future with "Market Design 3.0"
- This benefits case study documents the qualitative and quantitative benefits of market renewal



Overview

Enabling Market Evolution

- Conducted focus groups with IESO internal and working groups to identify the range of policy futures that the sector may face
- Clear takeaway is that concerns with the current design will be magnified in almost all futures, driven by :
  - Policy goals for decarbonization and potential for electrification
  - More intermittent resources and greater flexibility needs
  - Greater capital cost (lower variable cost system)
  - Distributed resources and customer choice
  - More interconnection and need to rely on interties for efficiency and reliability (both short-term and long-term)
- Key benefit of market renewal is to enable cost-effective market evolution under a range of possible futures

Electricity Sector "Futures" Identified In Visioning Workshops

Overview

Approach to Evaluating Benefits and Costs

+ Benefits

Energy
Operability
Capacity

1. **Review prior studies of Ontario's system**
   - Determine the scope of benefits considered in the Ontario studies and the consistency with expected benefits of the market renewal project
2. **Supplement with studies of other RTOs' design enhancements**
   - Consider the similarity and differences of the market characteristics and scope of design changes to translate benefits from other markets into the Ontario context
3. **Compile evidence across studies to develop an expected benefits ranges**
   - Develop baseline estimates; understand drivers/risks and uncertainty range to assess whether even lowest plausible benefits exceed implementation costs
   - For capacity, update IESO analysis with new supply outlook information
4. **Account for the implications of contracts**
   - Determine the share of potential benefits likely captured prior to (vs. after) contracts expire
   - Categorize contracts based on asset owner incentives to respond to improved price signals

– Costs

1. **Review costs and lessons learned from other RTOs**
   - Examine cost reporting and implementation circumstances
   - Interviews with others RTOs' staff and vendors (Siemens, ABB, GE/Alstom)
2. **Bottom-up indicative estimates based on IESO systems and personnel**
   - Utilicast review of IESO personnel, IT systems, and upgrade costs and avoided costs

= Net Efficiency Benefits

1. **Calculate present value of net benefits**
   - Benefits over 10 years 2021-30 (some capacity benefits earlier)

Overview

Preliminary Findings: Large Efficiency Benefits

Quantified efficiency benefits outweigh implementation costs by a large margin

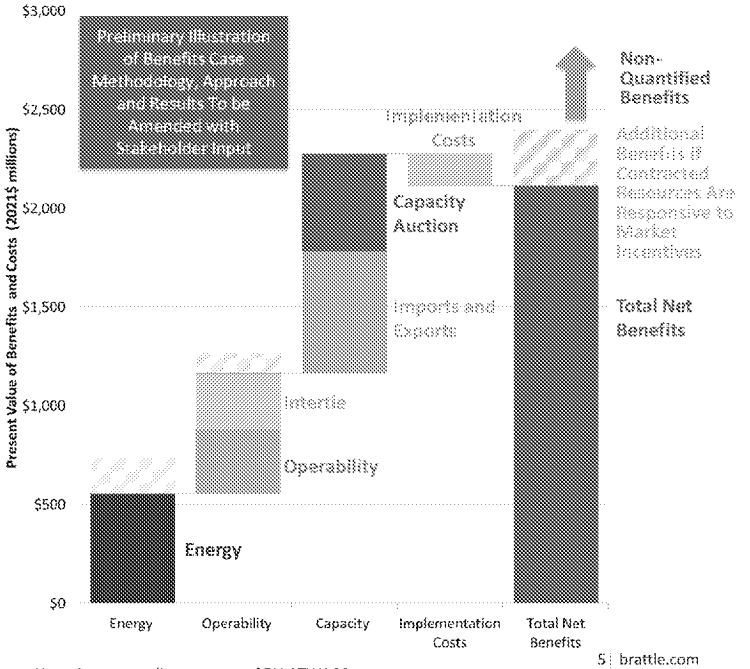
Efficiency Benefits (shown here)

- Baseline estimate: $2.1 billion NPV ($235 million per year from 2021-2030) in net benefits
- 14:1 benefit-cost ratio
- Additional benefits achievable if contracted resources are responsive to market incentives
- Benefits will vary based on scope of reforms and other factors, but exceed costs by ratio of 6:1 even with low-end benefits estimate

Customer Benefits

- Baseline estimate: $1.4 billion NPV (10:1 benefit-cost ratio, $154 million per year from 2021-2030) in net benefits

Present Value of Market Renewal Efficiency Benefits
(10 Years of Benefits 2021-30)



Note: Assumes a discount rate of 5% ATWACC.

Overview

Key Efficiency Benefits of Market Renewal

The proposed market renewal efforts offers a number of significant benefits to Ontario (many of these are non-quantified or only partially quantified in the benefits case):

- Optimized real-time unit commitment and dispatch, including look-ahead
- Optimized day-ahead commitments, including intertie schedules
- Reduced gaming, improved mitigation, more competition, fewer uplift costs and associated problems
- Better investment signals and investment cost savings
- Improved energy prices (advanced scarcity event and surplus baseload generation pricing); better dispatch signals for hydro, storage, and DR
- Avoided curtailments, enhanced flexibility, and system reliability benefits at higher renewable generation penetrations
- Enhanced intertie scheduling and pricing, while avoiding uplifts
- Insurance value of more flexible capacity procurement
- Support for innovation and technology advancement
- Provide a better platform for Market Design 3.0, pursuing policy objectives, and enabling market evolution

Sector Benefits

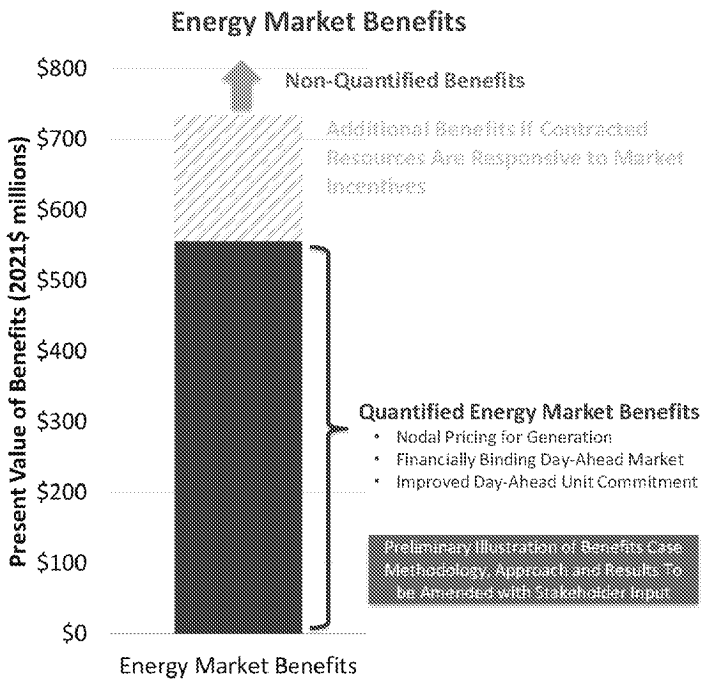
Energy Market Reform Benefits

Market Design 2.0

- Other markets have pursued similar design enhancements (MISO, ERCOT, SPP, California) and demonstrated large benefits (based on retrospective studies)
- Market conditions in Ontario (high renewables, inflexibility, contracts) create potential for even higher benefits

Quantified Benefits

- Baseline estimate: $555 million NPV ($70 million per year)
- 32% increase in benefits if contracted resources are responsive to market incentives



Sector Benefits

Energy Market Benefits Range

Energy market reform benefits could vary from baseline estimates due to:

- Specific Reforms Pursued: Different scope and implementation quality (deviations from best-practice)
- Flexibility of Existing Generation Fleet: A more inflexible system presents a greater opportunity to create benefits through market-driven dispatch
- Renewable Penetration: High levels of variable generation constrain the system, creating the opportunity for higher benefits

Possible PV range of quantified benefits: $210 million to $1.2 billion

- Even the low end of this range, combined with the low end of plausible benefits from the other two work streams exceeds implementation costs by a ratio of 6:1

Additional (non-quantified) benefits include:

- Incremental benefits of Market Design 3.0
- Optimized real-time unit commitment and dispatch, including look-ahead
- Reduced gaming, improved mitigation, more competition
- Better investment signals and increased efficiency of investment
- Improved energy prices (advanced scarcity event and SBG pricing); better dispatch signals for storage and DR
- Support for innovation and technology advancement

Sector Benefits

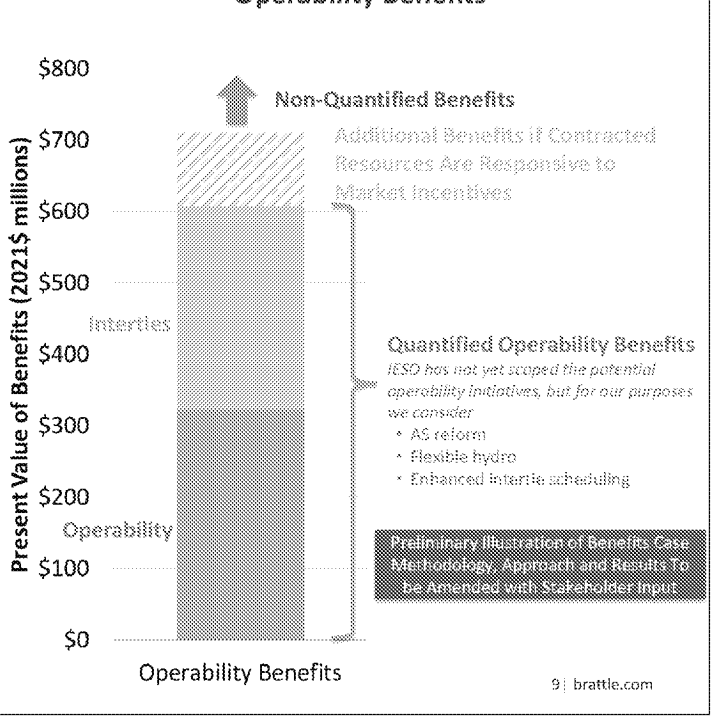
Operability Benefits

Operability

- Increasing intermittency and relatively inflexible fleet are a growing concern as Ontario decarbonizes
- Market Design 3.0 will need to harness flexibility potential from existing fleet (especially hydro), interties, DR, storage, and new technologies

Quantified Benefits

- Baseline estimate: $610 million NPV benefits ($75 million per year), half from interties
- 17% increase in benefits if contracted resources can be made more responsive



Sector Benefits

Operability Benefits Drivers and Range

Operability reform benefits could vary due to:

- Specific Reforms Pursued: Different scope and implementation quality will drive size of achievable benefits
- Extent of Intertie Optimization
- Flexibility of Existing Fleet: Existing flexibility that may not be fully utilized,
- Proportion of Intermittent and Inflexible Generation: High levels of intermittent and inflexible generation constrain the system, increasing value of flexibility

Possible PV range of quantified benefits: $285 million to $1.1 billion

- Even the low end of this range, combined with the low end of plausible benefits from the other two work streams exceeds implementation costs by a ratio of 6:1

Additional (non-quantified) benefits include:

- Other ancillary service types
- Avoided curtailments and benefits at higher wind penetrations
- Investment cost savings
- Intertie benefits with neighboring (non-market) provinces
- Reduced gaming
- Innovation from new technologies

Sector Benefits

Capacity Auction Benefits

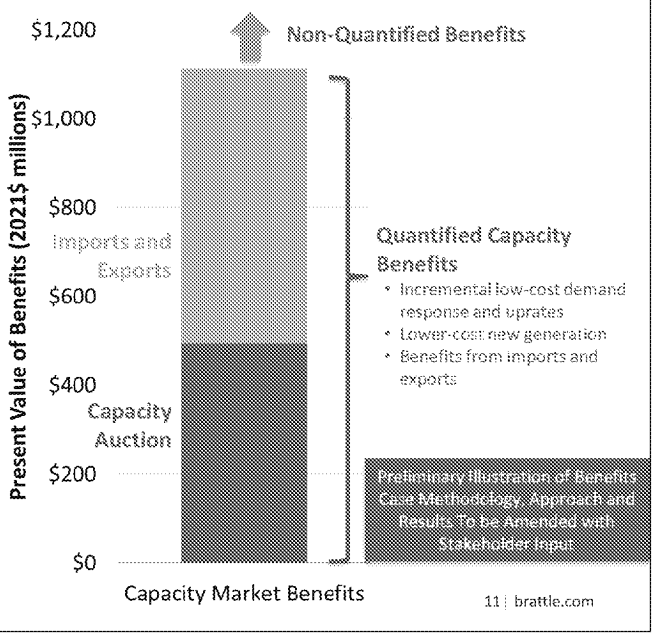
Capacity Auction

- Other regions' capacity markets have a successful track record of attracting low-cost and non-traditional resources such as demand response, uprates, imports, and new generation
- PJM customers benefitted from deferring new investment for a decade
- Capacity exchange will allow for increased revenue from exporting excess supply (option to import lower-cost supply when needed)
- Re-align risk allocation to the party that is best able to manage risks

Quantified Benefits

- Baseline estimate: More than $1.1 billion NPV in benefits ($115 million per year over 2020-30) estimated for Ontario (higher with more load growth)

Benefits from Imports, Exports, and Capacity Market (Exports Starting 2017, plus Auction 2020-30)



Sector Benefits

Capacity Auction Benefits Range

Capacity procurement reforms could vary due to:

- Load Growth: Higher load growth allows new capacity to be brought online at a lower price (less need for capacity results in less opportunity for benefits)
- Existing Generators' Costs: The more expensive it is for generators to stay online, the larger the savings from new low cost capacity
- Imports/Exports: Increased import/export capability, and greater price differences with external markets, the greater the benefits
- Low-Cost Resources: The cheaper and more abundant that low cost resources are (such as uprates and DR), the greater the benefits

Possible PV range of quantified benefits: $480 million to $2.3 billion

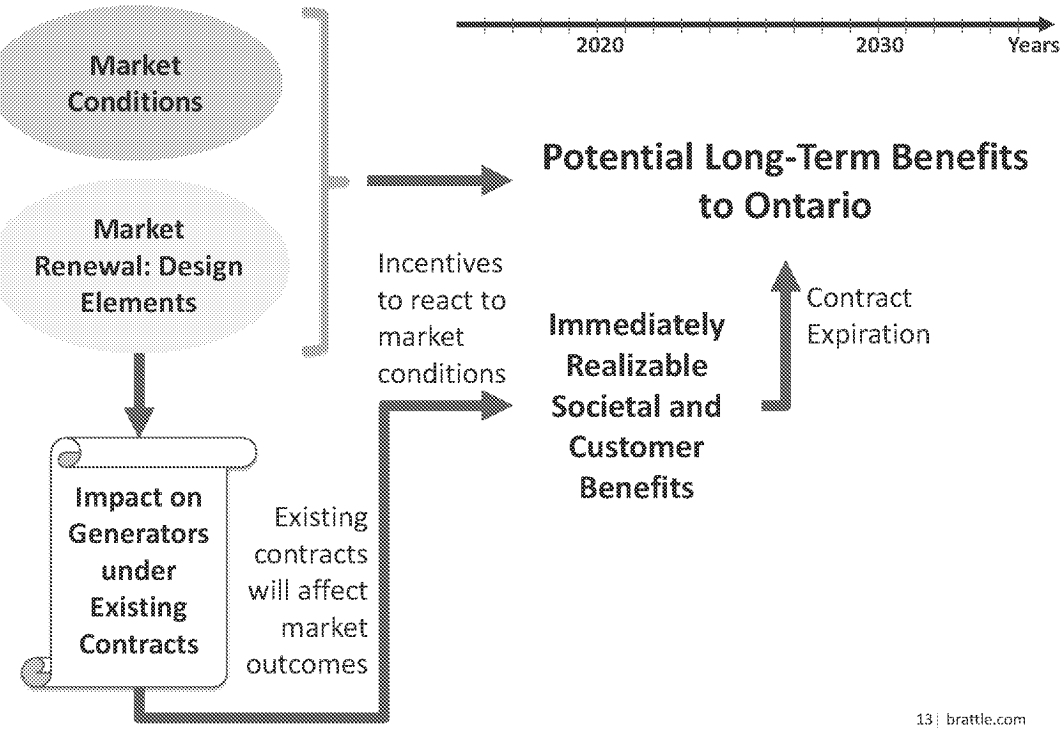
- Even at the low end, when combined with the low end of plausible benefits from the other two work streams, total benefits exceed implementation costs by a ratio of 6:1

Additional (Non-Quantified) Benefits include:

- New low-cost technologies (such as energy storage)
- Seasonal capacity market could allow for additional imports or exports if the surrounding regions peak in a different season, and enable different resource types
- Flexible resource requirements, if needed, could be procured in a competitive fashion through capacity auctions, including from new technologies
- Locational Capacity Value would allow the procurement of capacity where it is most valuable

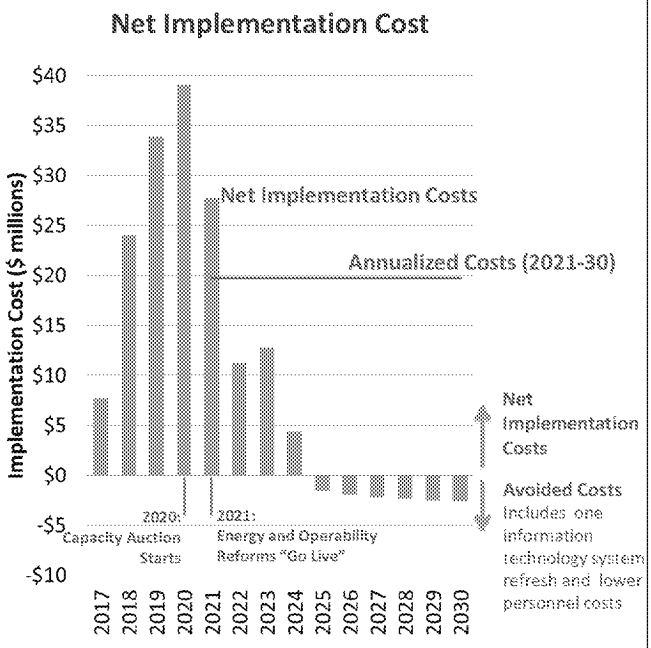
Sector Benefits

Accounting for Contracts



Implementation Costs

- Bottom-up estimates of potential IESO implementation costs developed by Utilicast
- Baseline net cost estimate: $147 million (including 15% assumed contingency)
- Net of avoided costs from: (1) investments that would need to be made regardless and (2) reduced long-term staff requirements
- Costs likely lower than in some other markets that implemented nodal and day-ahead markets due to more advanced starting point in IESO compared to other markets
  - e.g., IESO already has full network model and centralized unit commitment
- Lessons from other markets can be used to mitigate cost risks



Notes: Cost levelization assumes 5% ATWACC, annualized over 10 years.

Implementation Costs

Drivers and Range of Implementation Costs

Range of Implementation Costs

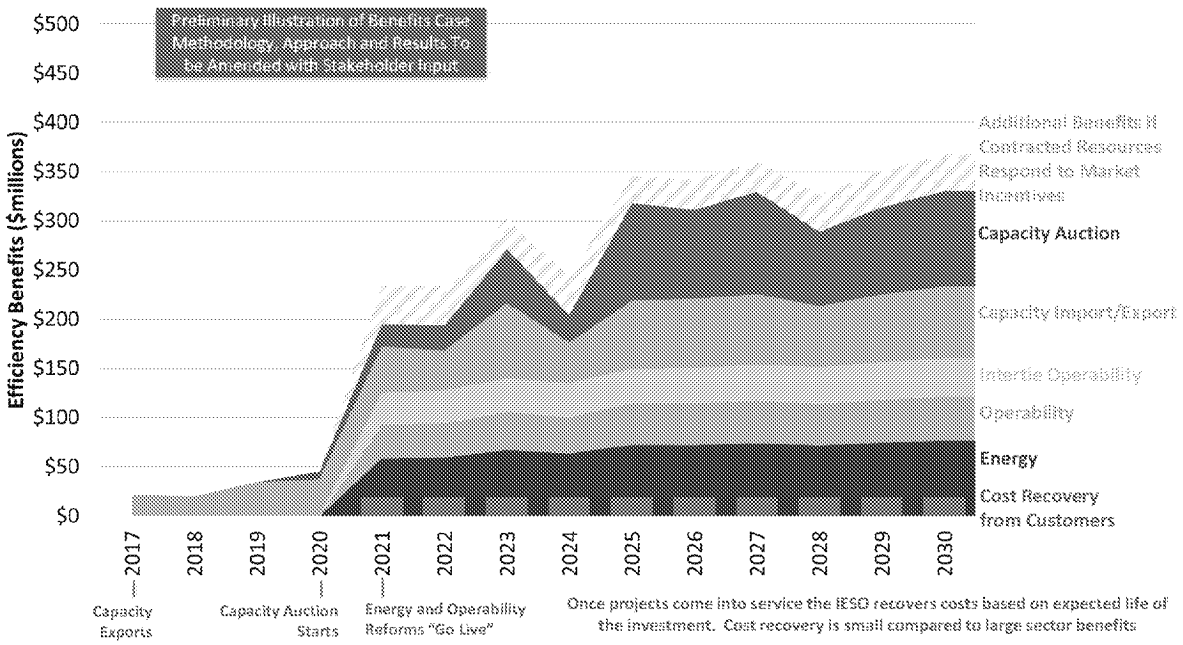
- Cost are only indicative at this point due to the early stage of the project, and will depend on:
  - Scope of design changes IESO ultimately pursues
  - What design scope the selected vendor can implement mostly "off the shelf" vs. on a customized basis (the base estimate assumes a moderate level of customization)
  - Level of system integration required across systems (e.g. between two vendors)
  - Timeline of implementation (e.g. avoided IT costs may not be avoided if the project is delayed)
- Utilicast developed an illustrative higher-cost scenario at $261 million. This scenario assumes $49 million in higher technology costs, $39 million in additional personnel and consulting costs associated with a longer timeline, $16 million if no costs can be avoided, and a $10 million additional contingency cost

Lessons Learned from other RTOs

- **Focus on Benefit-Cost Ratio:** Do not think about this as an exercise in minimizing costs, the market renewal is about maximizing benefits. The large benefit-cost ratio for a better system is worth the cost given the scale of benefits that can be achieved
- **Do it right the first time**: Short cuts can cost more in the long term (both in implementation costs and system costs). For example, CAISO incremental steps on 1-hour and 15-minute intertie scheduling resulted in high costs compared to going right to 5-minute scheduling
- **Avoid changing direction mid-stream** during implementation (mitigate scope creep and change-orders through better up-front design work). This better controls vendor costs and internal staff costs from reworking, avoids non-productive idle periods, delay implementation, longer periods with duplicate systems and staffing needs, and distracting from the main purpose of the design upgrades

Preliminary Findings

Efficiency Benefits Grow Over Time

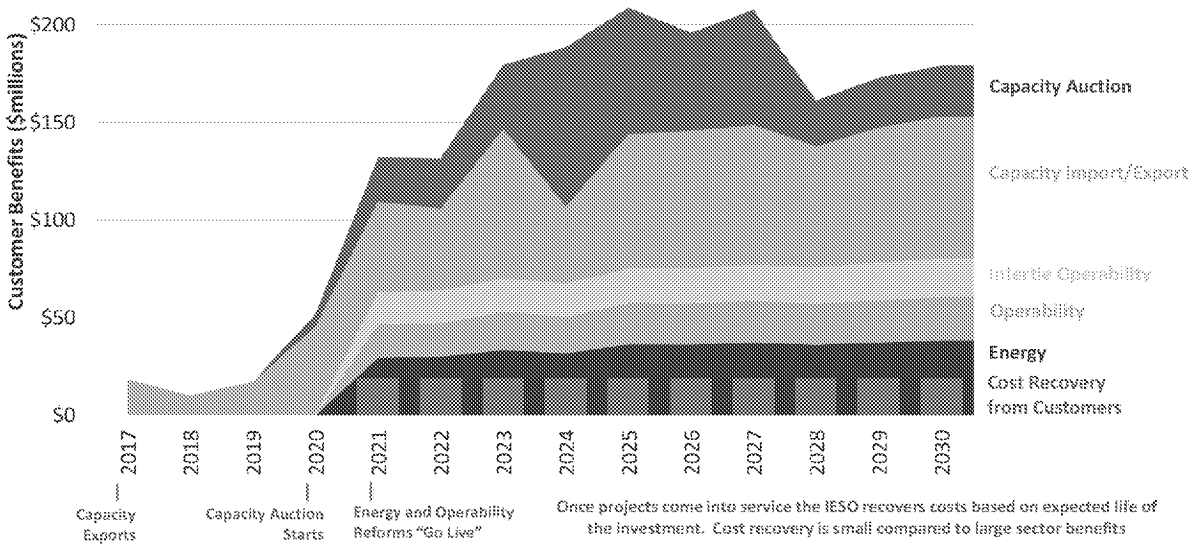


Notes: Cost levelization assumes 5% ATWACC over 10 years.

Preliminary Findings

Customer Benefits

Preliminary Illustration of Benefits Core Methodology, Approach and Results To be Amended with Stakeholder Input



Capacity Exports

Capacity Auction Starts

Energy and Operability Reforms "Go Live"

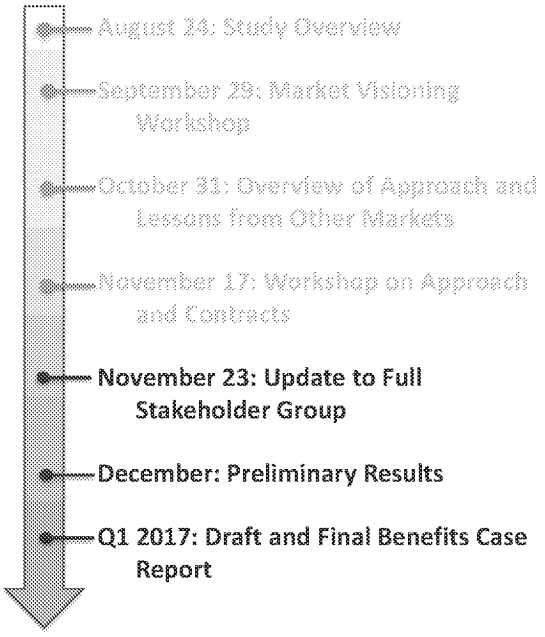
Once projects come into service the IESO recovers costs based on expected life of the investment. Cost recovery is small compared to large sector benefits

Notes: Cost levelization assumes 5% ATWACC.

Next Steps

- Finalize preliminary results in December 2016
  - Draft results reported here are solely based on our own initial assessment
  - Will need to be refined based on additional input on methodology from IESO staff, working group, and stakeholders
- Draft report to be issued in early Q1 2017
- Final report in late Q1 2017

Stakeholder Milestones



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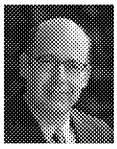

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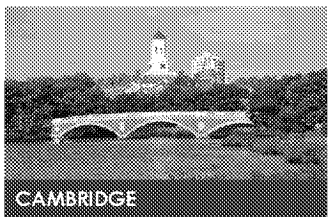
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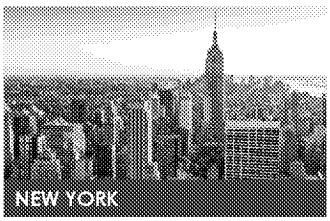
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