Solar Ontario:
The Future Capacity Market and Electricity Market Reform

November 14, 2018

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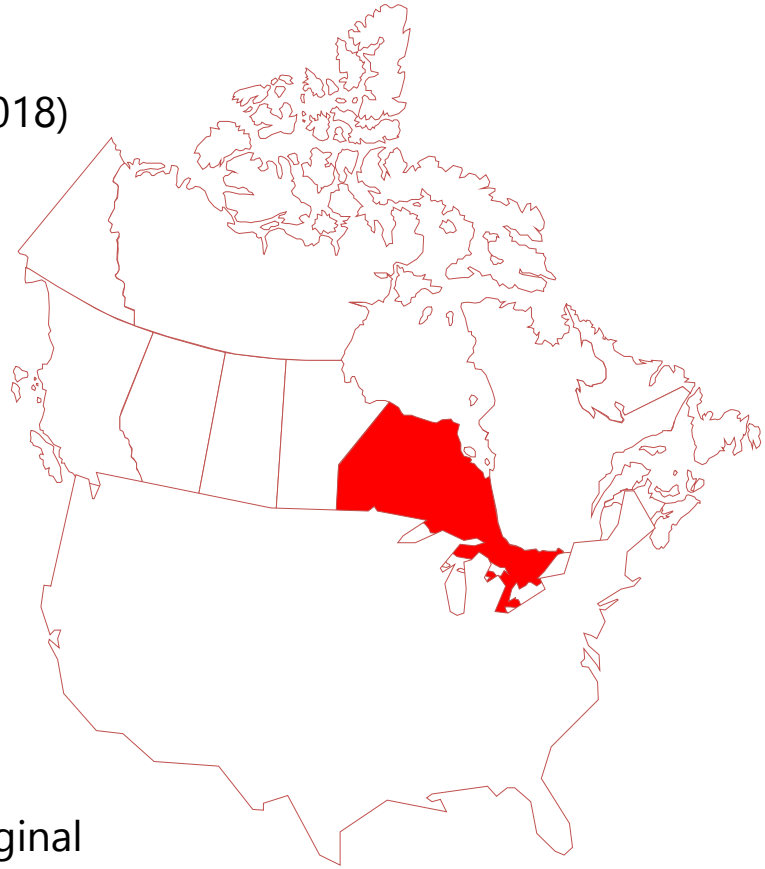
Ontario Electricity Market

- $20B per year
- Peak demand: 27,000 MW (2006), now 22,000 MW (2018)
- Generation capacity: 40,000 MW
- Interconnections: 5,000 MW
- Transmission lines: 30,000 km
- Wholesale and retail electricity markets – over 300 registered wholesale market participants
- IESO Market Renewal Program (MRP): Locational Marginal Prices (LMPs); Day-Ahead Market (DAM); Enhanced Real-Time Unit Commitment (ERUC); Incremental Capacity Auctions (ICAs)



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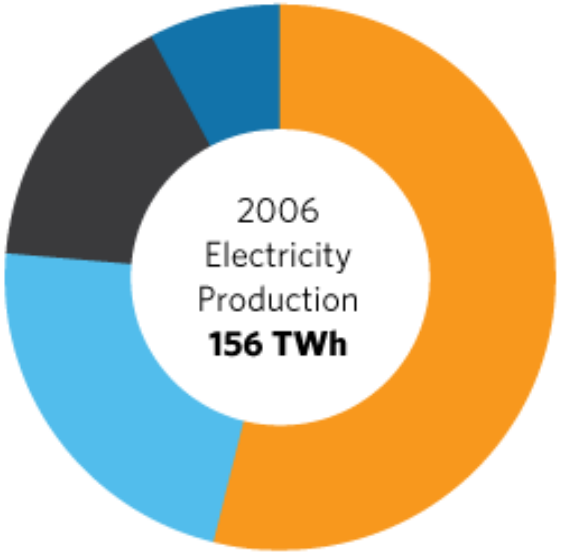
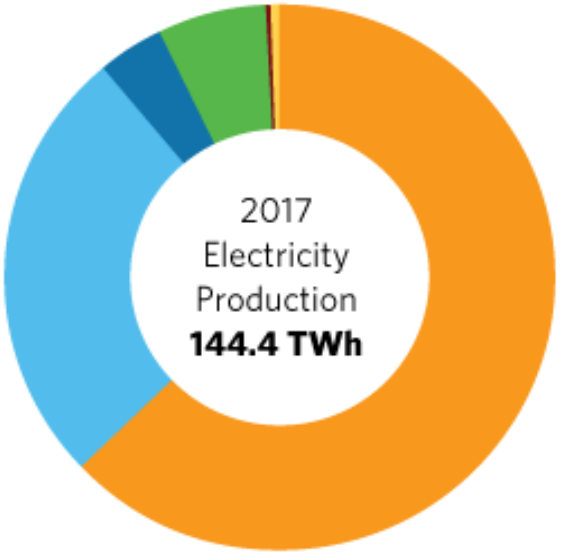
Changing Ontario Energy Supply (2006 and 2017)



Nuclear	84.4 TWh or 54%
Hydro	34.8 TWh or 22%
Coal	25 TWh or 16%
Other (gas, oil, alternative sources)	11.8 TWh or 8%



Nuclear	90.6 TWh or 63%
Hydro	37.7 TWh or 26%
Gas/Oil	5.9 TWh or 4%
Wind	9.3 TWh or 6%
Biofuel	0.4 TWh or <1%
Solar	0.5 TWh or <1%

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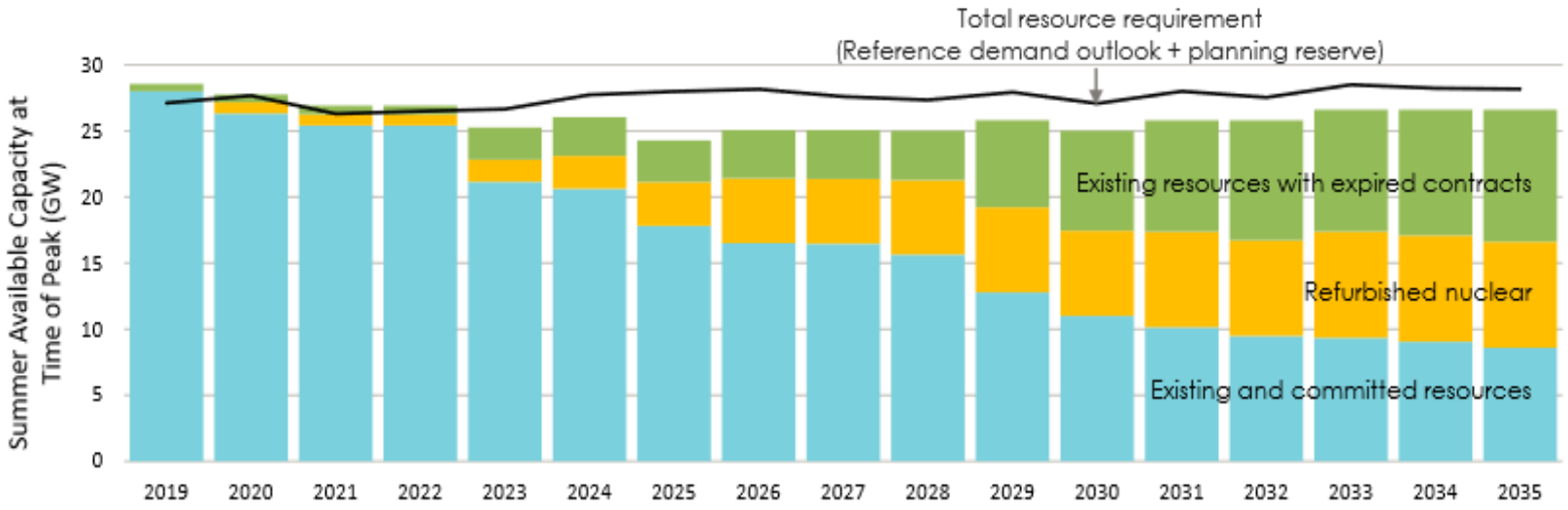
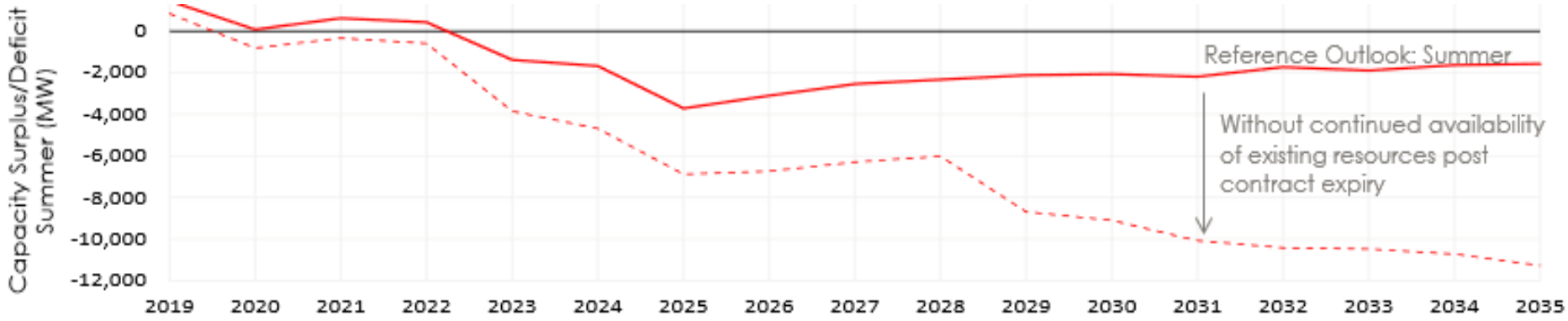
Ontario Projects to Need Capacity Beginning in 2023 Lasting Through 2030s (IESO: September 13, 2018)





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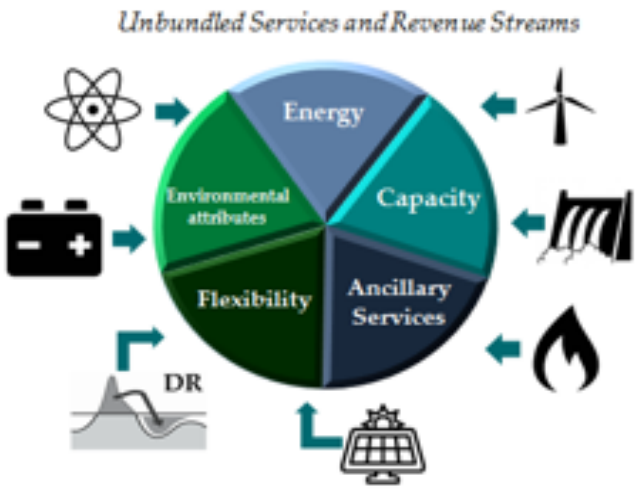
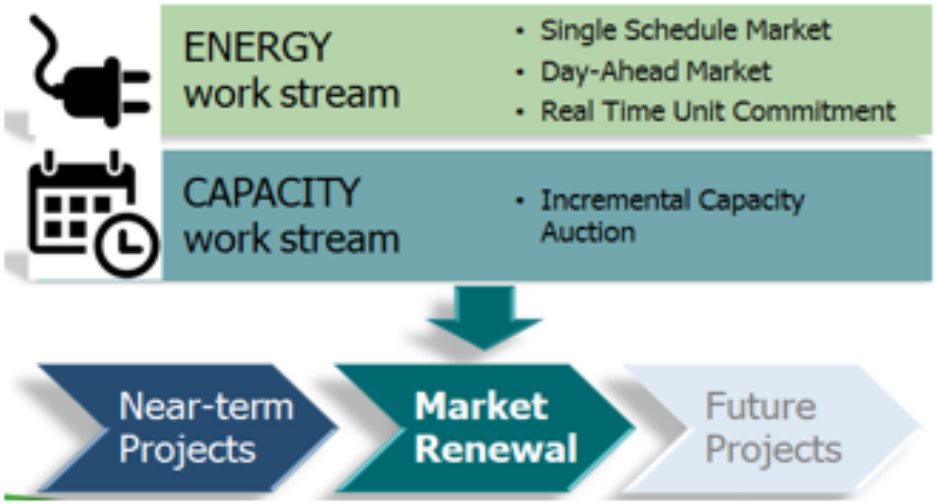
IESO MRP: U.S. Standard Market Design – LMP, DAM, ERUC

The "VISION"



The "HOW"



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

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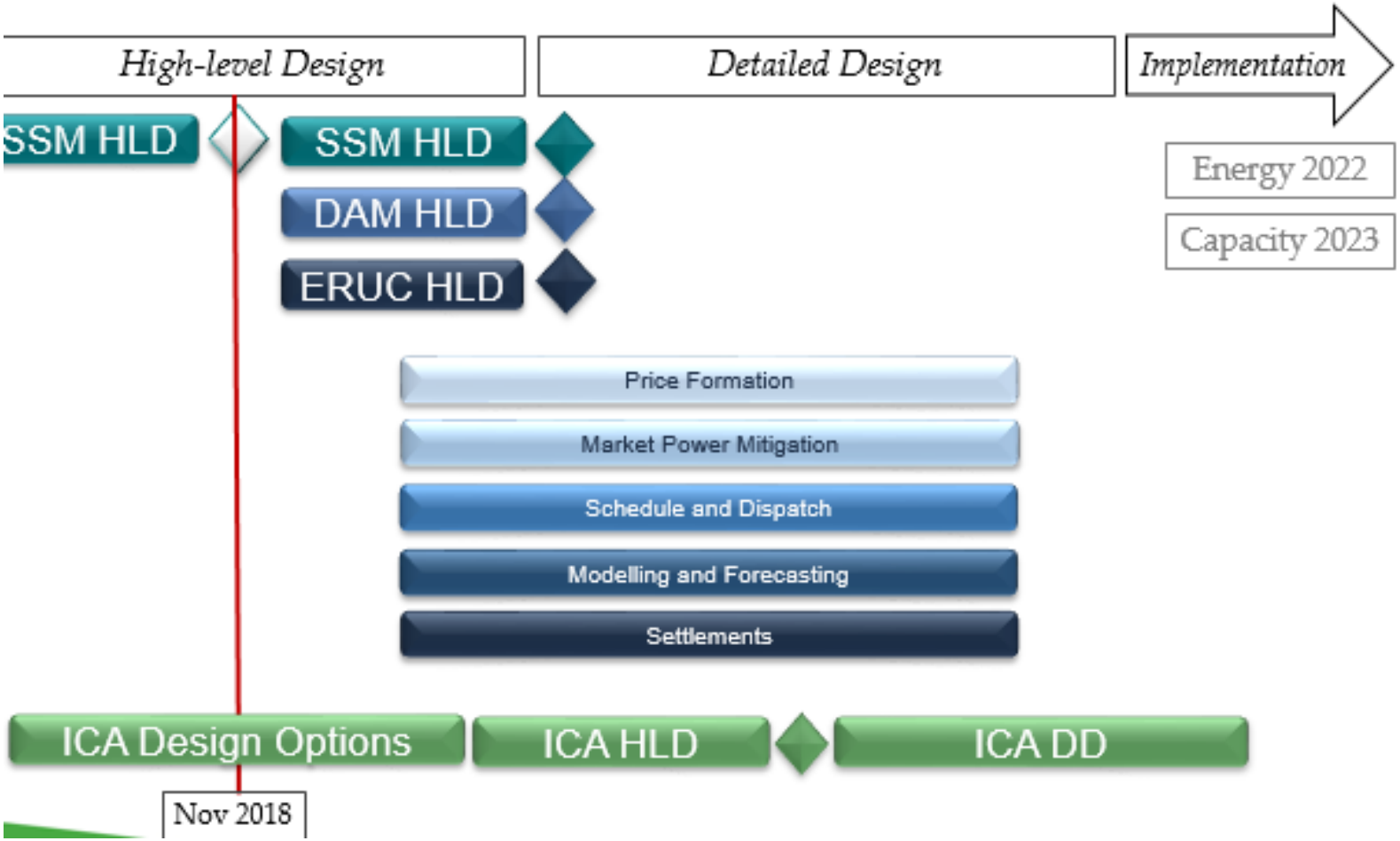
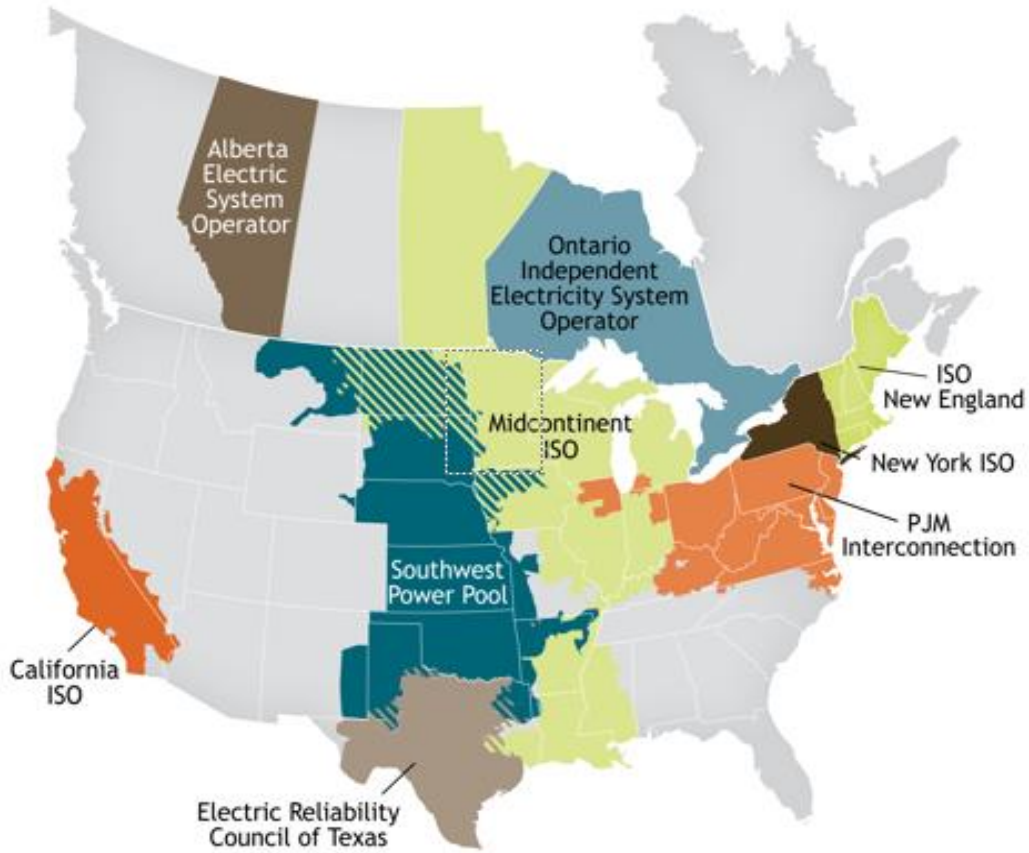
IESO MRP – Design and Implementation Timelines



Wholesale Market Design – Challenges with Capacity Markets



- 9 power markets characterized by
  - Real-time energy (day-ahead in U.S.)
  - Ancillary services
  - Capacity (ISO-NE, NYISO, PJM, designed for AESO)
- Challenges with Capacity Markets
  - Not universally administered
  - Ever changing design/rules
  - Provinces/states procuring (e.g., contracting) resources (e.g., renewables) not through Capacity Markets
  - Controversial changes being implemented (ISO-NE) and proposed (PJM)
- What does this mean for Ontario and IESO MRP plans? What does this mean for solar in Ontario?

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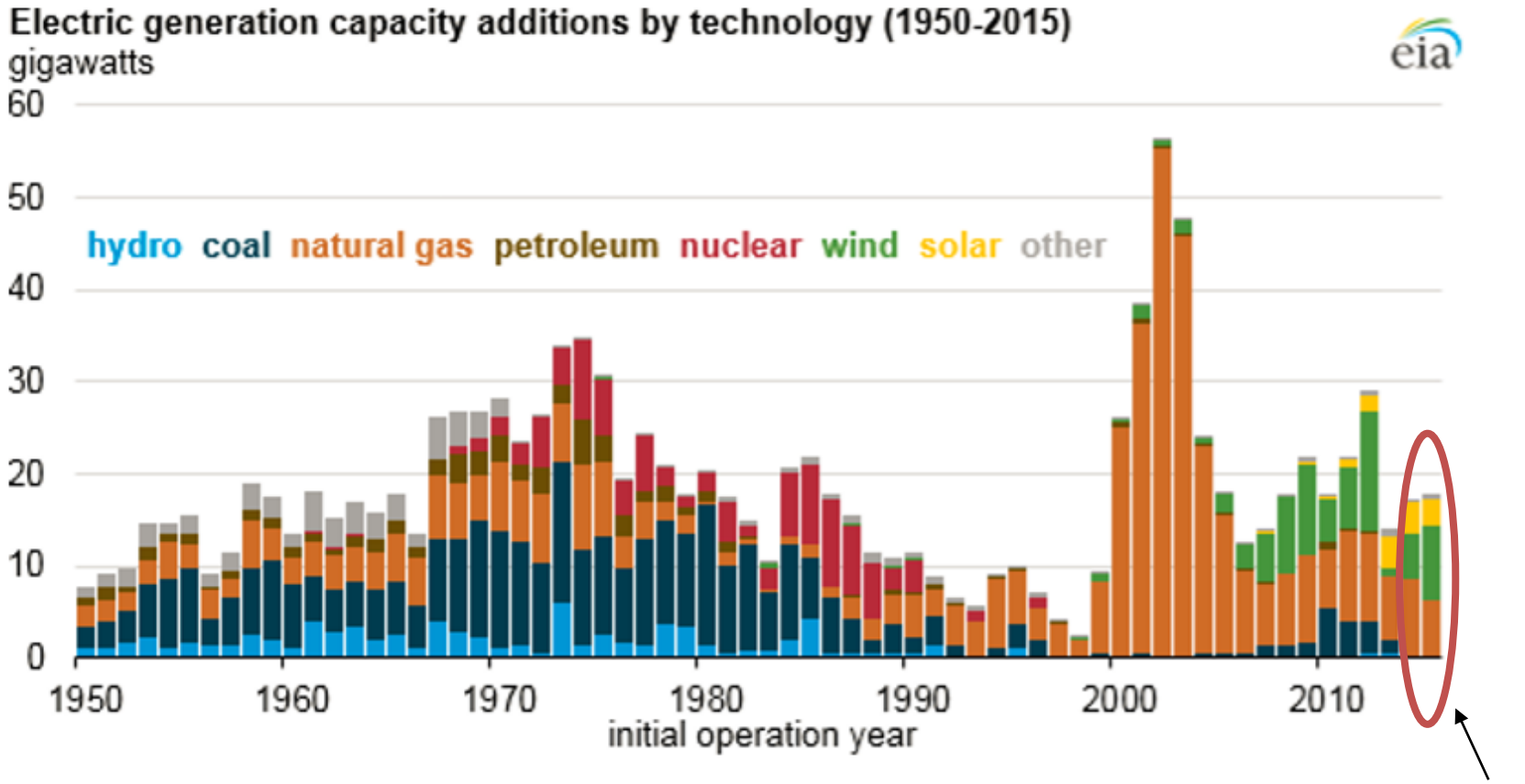
Implications for Solar Generation in Ontario and in General for IESO MRP

- Potential implications for solar generation in Ontario
  - Less contracting with IESO
  - Unknown costs to customers (e.g., impacts of LMPs on Global Adjustment (GA), rate design (e.g., Regulated Price Plan (RPP), net metering) – uncertain business case for rooftop solar generation
  - Very little solar generation 'clears' Capacity Markets – ICAs likely same outcome

- Emerging major, long-term issues without present consensus – implications for IESO MRP (including ICAs)
  - Are markets adequately accommodating public policy goals? What regulatory and market design changes would further enable deployment of resources that achieve goals of reliability, affordability, innovation, resource mix?
  - What are the market impacts of environmental regulations that further constrain deployment of needed resources?
  - What are the market impacts of integrating higher levels of non-emitting resources (NERs) and distributed energy resources (DERs)?
  - Are today's markets and regulatory frameworks adequately designed to acquire needed resources to better integrate multiple resources?

Increasing Variable (Solar and Wind) Generation Supply



- U.S. supply trends: coal (1950s-1980s); nuclear (1970s-1980s); natural gas (1990s-2000s); renewables (2010s+)

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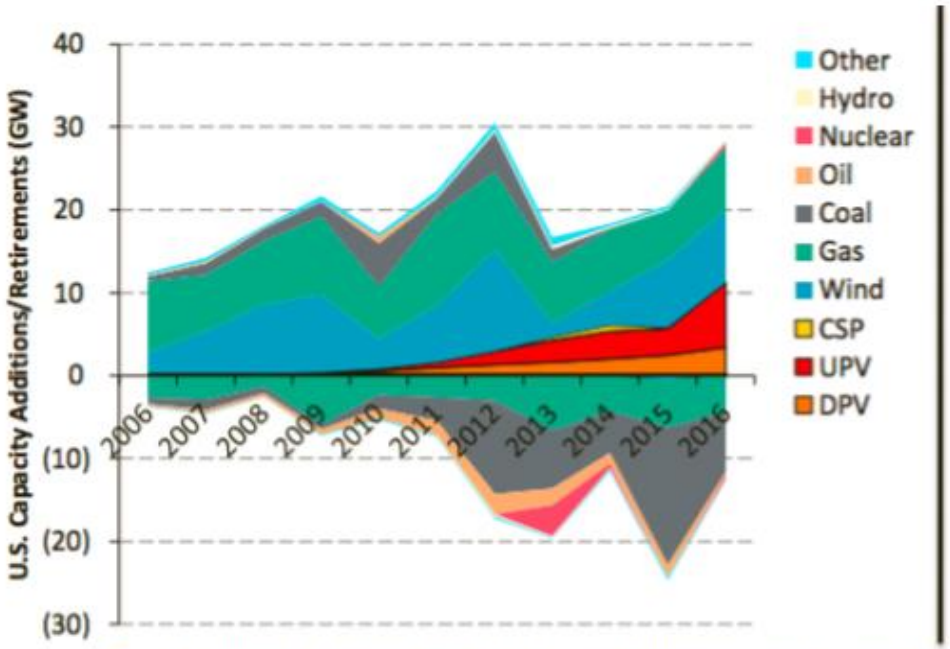
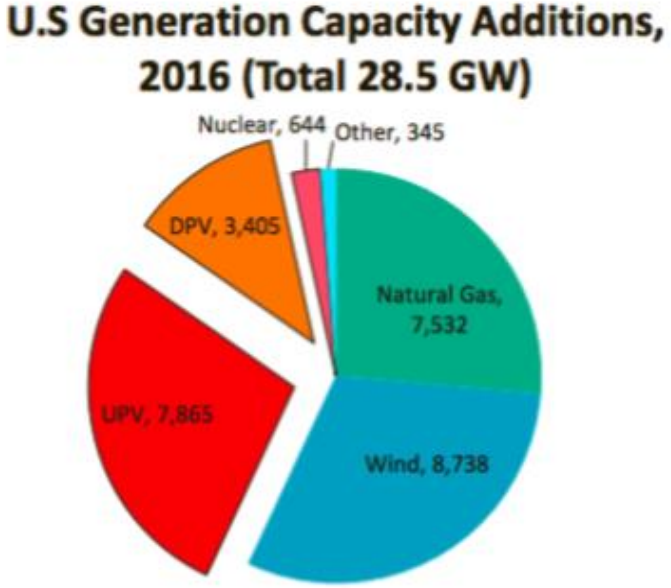
Increasing Variable Generation Supply

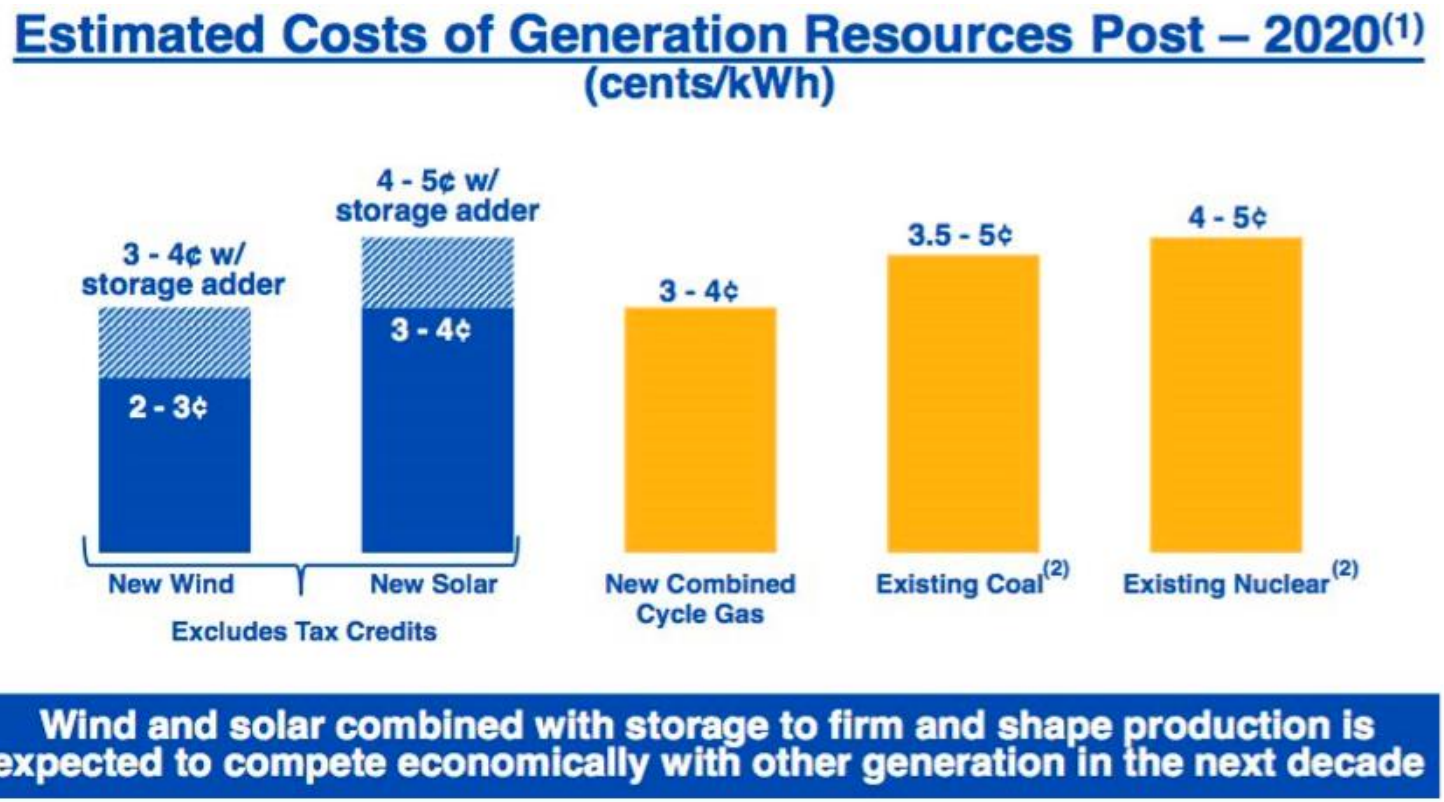




- In 2016, for the first time in U.S. history, solar was the largest source of new electricity generation capacity, with approximately 40% of all new generation capacity.
  - Wind and solar combined for 70% of new generation.

- Increasing variable generation supply partially driving increasing energy storage development

Supply Resource Cost Projections – NextEra Energy June 22, 2017 Investor Conference



- Some U.S. jurisdictions project some NERs (e.g., wind+storage, solar+storage) to be on par with 'conventional' generation on a levelized cost basis, projecting to continue increasing development of these NERs

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