Renewables-Based Distributed Energy Resources (DER) and Emission Reduction

An unfortunate cost truth for Ontario, a jurisdiction largely without fossil fuel generation

Reshaping Energy 2018: Today and Tomorrow

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STRATEGIC POLICY ECONOMICS

Overview

Distributed Energy Resources (DER) seen as a game changer → Costs widely praised as declining

DER is typically connected to distribution networks, is smaller in scale, includes renewables, storage and other options

DER economics, present and future, are relevant for Ontario

- Ontario has an emerging capacity gap → 30% of capacity to be renewed or replaced by 2035
- Renewables-based DER is given prominence in Ontario's 2017 Long-Term Energy Plan (LTEP) as a preferred supply option

Generally, DER objectives centred around need for storage to:

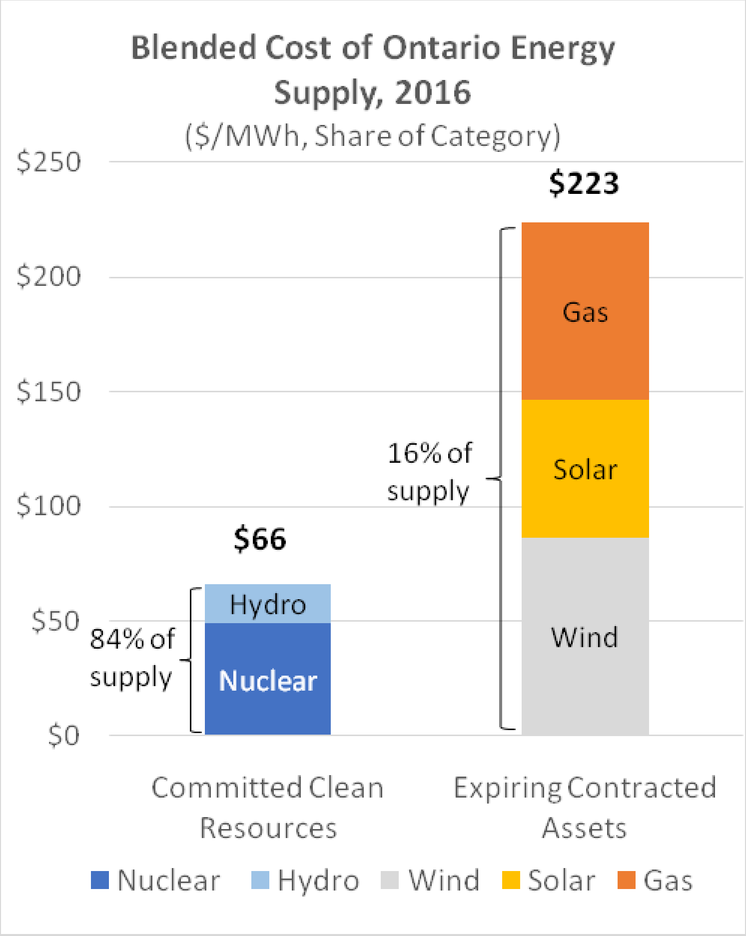
- Address system reliability, resiliency, and flexibility challenges created by renewables
- Justify more renewables by mitigating intermittency
- Optimize generation, distribution, and transmission asset utilization

Optimal role of renewables-based DER is to fully supply a demand need

What is unfortunate?

- Costs are declining, but not sufficiently for integrated systems to be competitive
- Intermittency causes need for backup generation, adding cost
- Ontario renewables not as reliable as in the U.S.

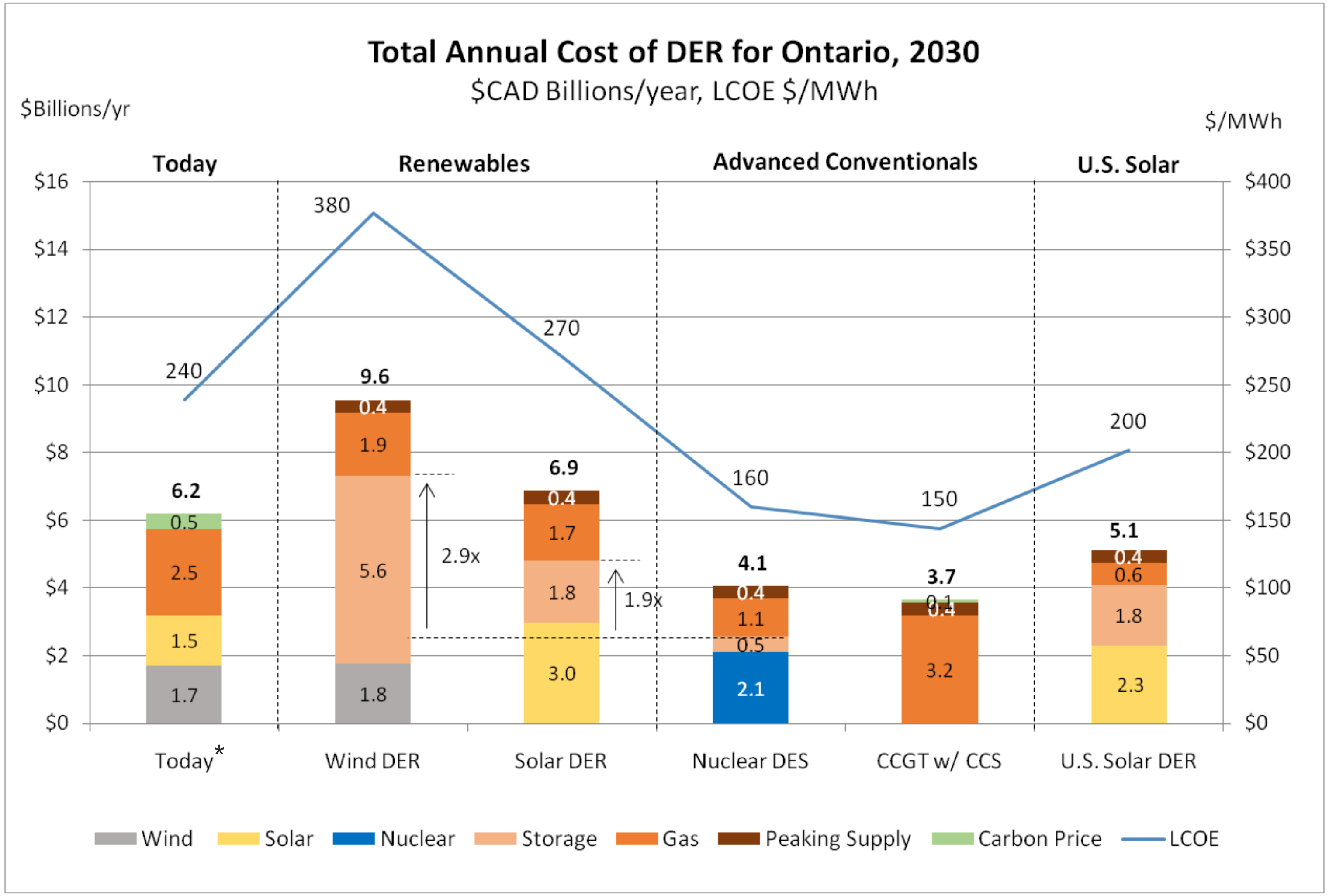
Ontario's emerging capacity gap relates to expiring high cost supplies



Source: OEB RPP Price Report, May 2017, Strapolec analysis

Renewables-Based DER Are the Most Expensive Options

11% to 45% more costly than today, 70% more to over double the cost of alternatives



Source: OEB, EIA, Strapolec analysis * LCOE is today's plus carbon price. Total cost adjusted to same demand as other cases

Today

- Wind, solar and gas would cost $240/MWh with 2030 carbon price of $100/tonne

Wind-based DER

- Grid-connected wind co-located with compressed air energy storage systems (CAES)

Solar-based DER

- Integrated solar panels and Li-ion batteries at the community or microgrid-scale

Nuclear baseload-supplied DES

- Grid-connected baseload generation supplying distributed energy storage (DES)
- Storage manages demand

CCGT with CCS

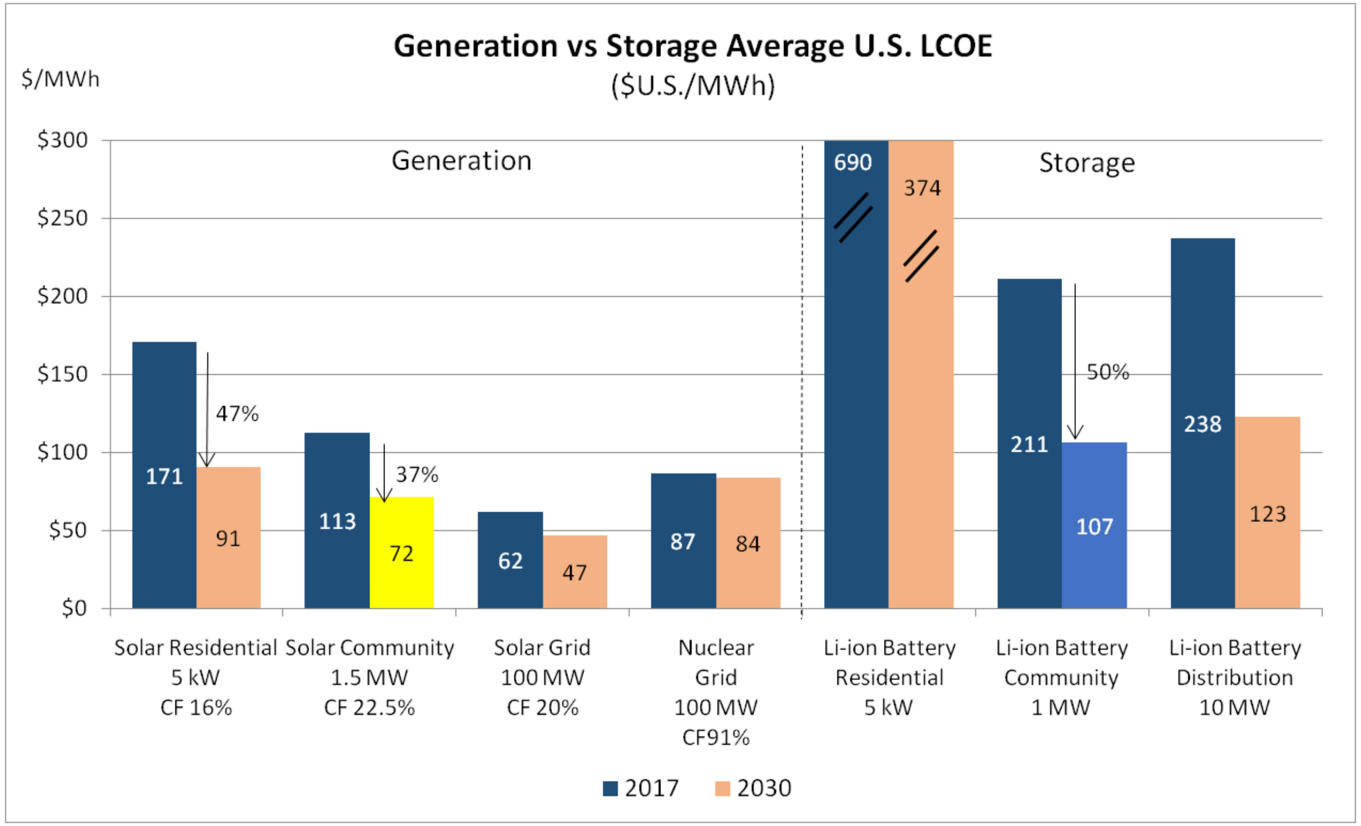
- Combined-cycle gas turbine (CCGT) equipped with carbon capture and sequestration (CCS)
- Could be future lowest cost solution

Levelized Cost of Energy (LCOE) of Solar and Storage are Declining

However, DER-scale installations will remain high cost beyond 2030

Community-scale solar LCOE to decline by 37%, and storage by 50%

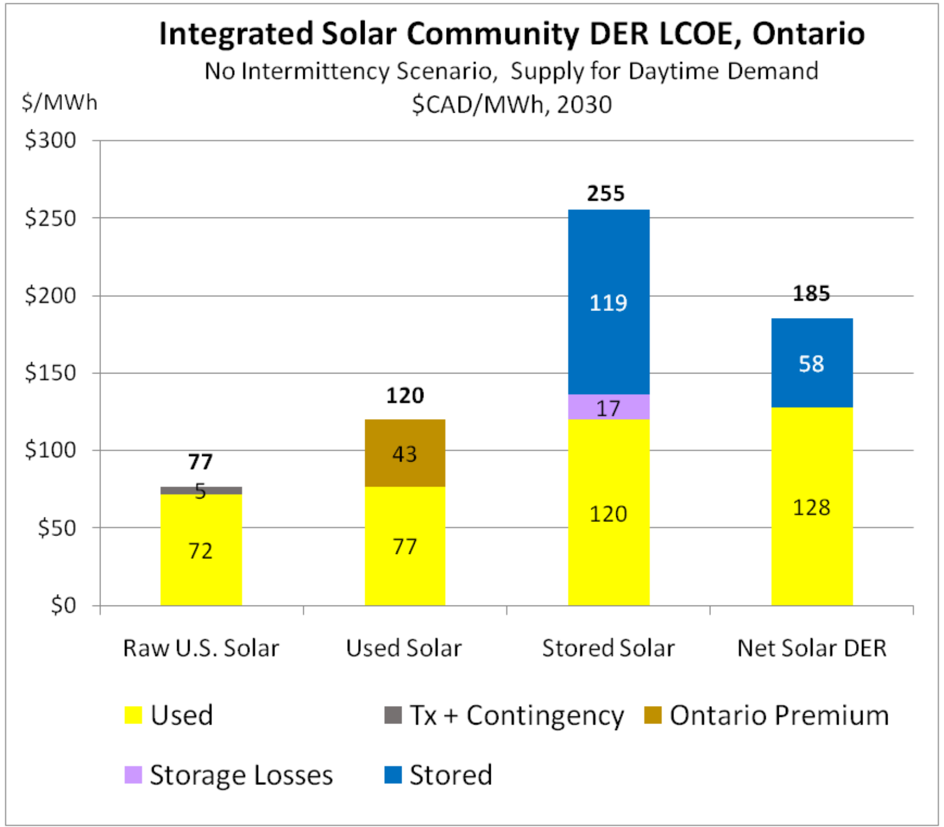
- Solar capital costs to decline similarly, storage capital costs to decline by 66%



Sources: EIA, NREL, Lazard, Leidos, Strapolec analysis, excluding Tx and technology risk factors

Integrated cost of DER is $185/MWh

Community solar cost of US$72/MWh increases to CA$120/MWh



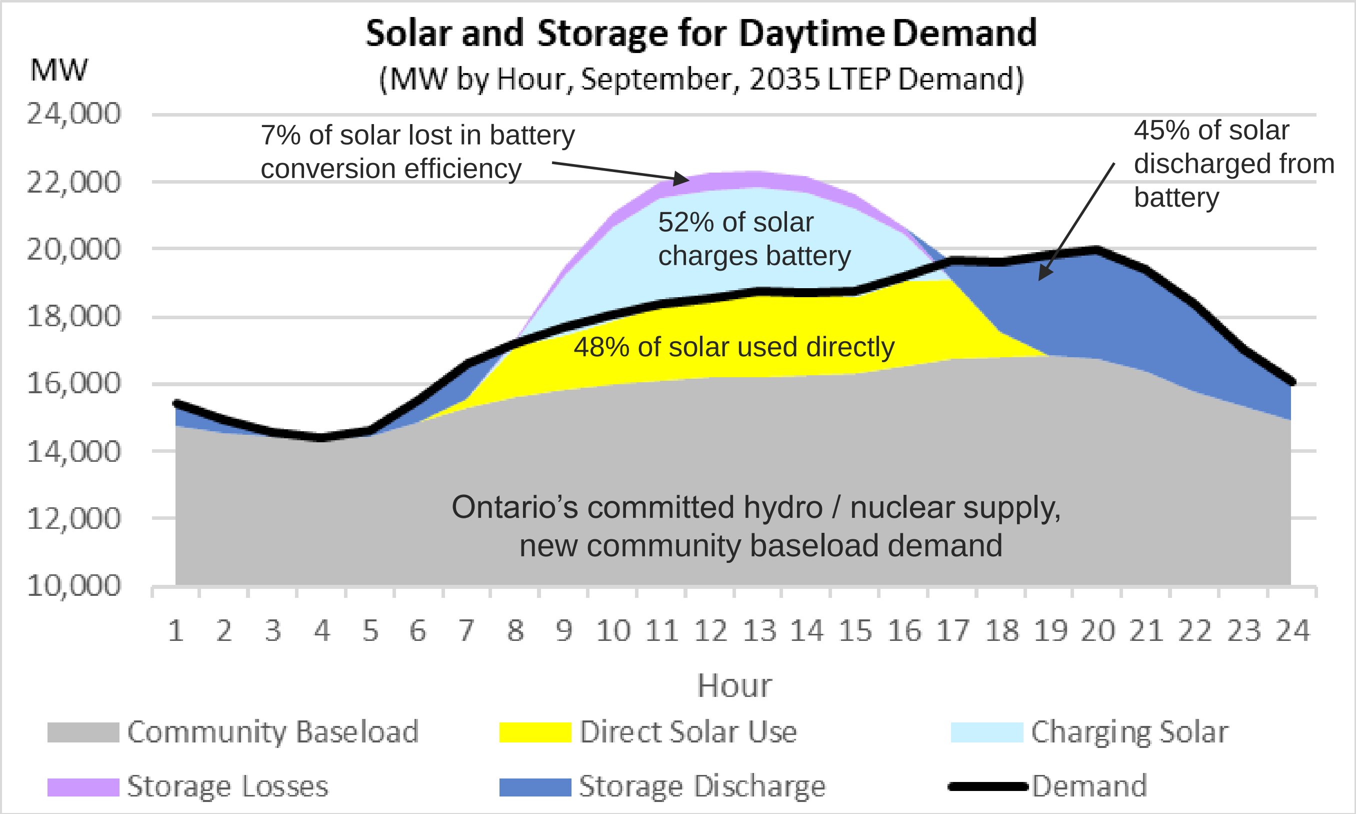
Ontario cost premium includes: exchange rate (15% applied to imported components), cost of building in Ontario, capacity factor implication

Integration of Renewables and Storage – Ideal Design Case

DER output should match the demand profile, with battery sized to average demand and solar output

To supply daytime demand, storage / solar combination emulates a gas plant

- Storage sized to capture 52% of solar energy
  - with 45% available after 7% losses



Sources: IESO generation and demand actuals, LTEP demand forecast, Strapolec Analysis

Ontario has a fossil free clean flexible baseload supply

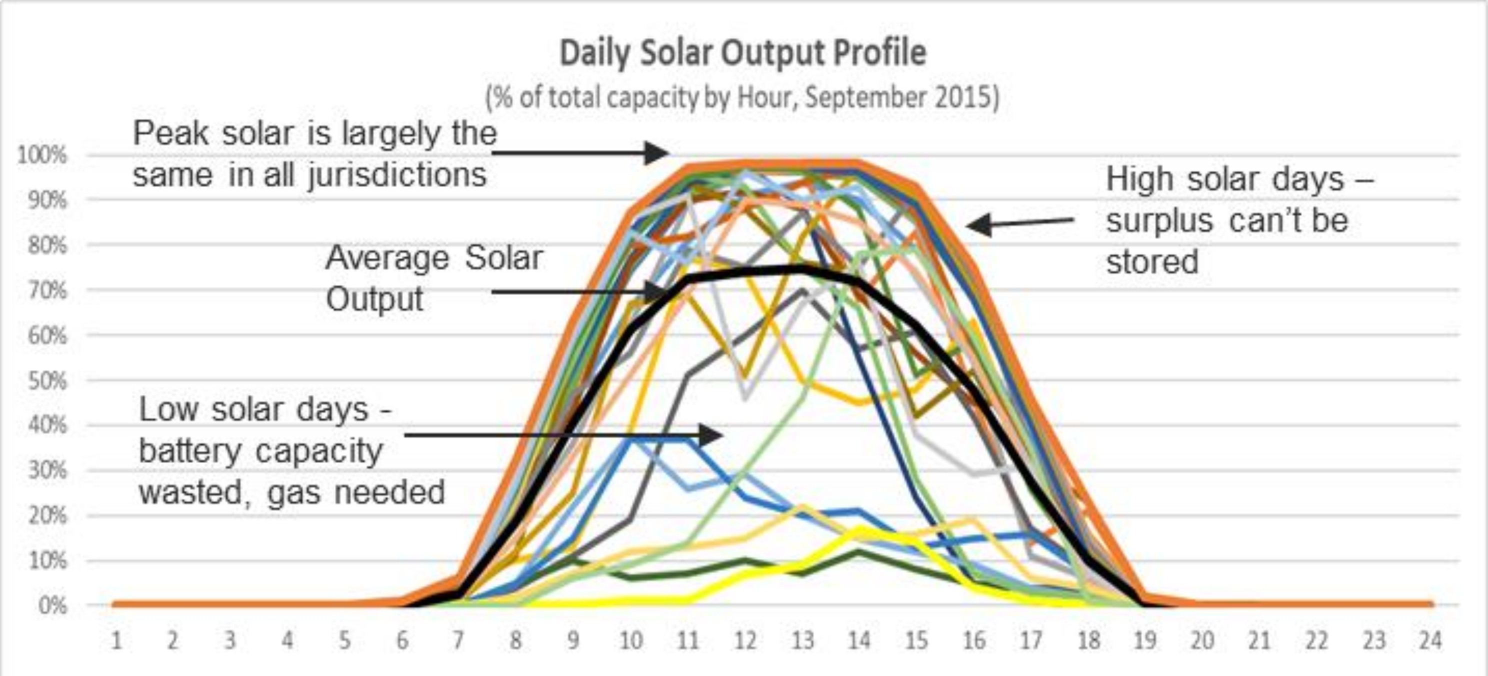
- DER would supply the demand not already serviced by the clean hydro and nuclear generation
- Ontario baseload has limited built in storage already used to manage demand
- Important assumption for costing purpose
  - Otherwise DER costs imposed on the baseload supply

Blended cost of this ideal system = $185/MWh

Intermittent Output Increases Cost of Storage and Backup

Ontario solar output varies significantly Hour-to-Hour and Day-to-Day

The average solar output is used to size system … but the intermittency makes some of that energy not available



Source: September 2015 IESO actuals, not curtailed, Strapolec analysis

Impacts of Intermittency

Peak solar output can occur in any month

- High solar output is *wasted*
- *Requires backup* to balance total energy to achieve the average

Low solar output caused by cloud cover

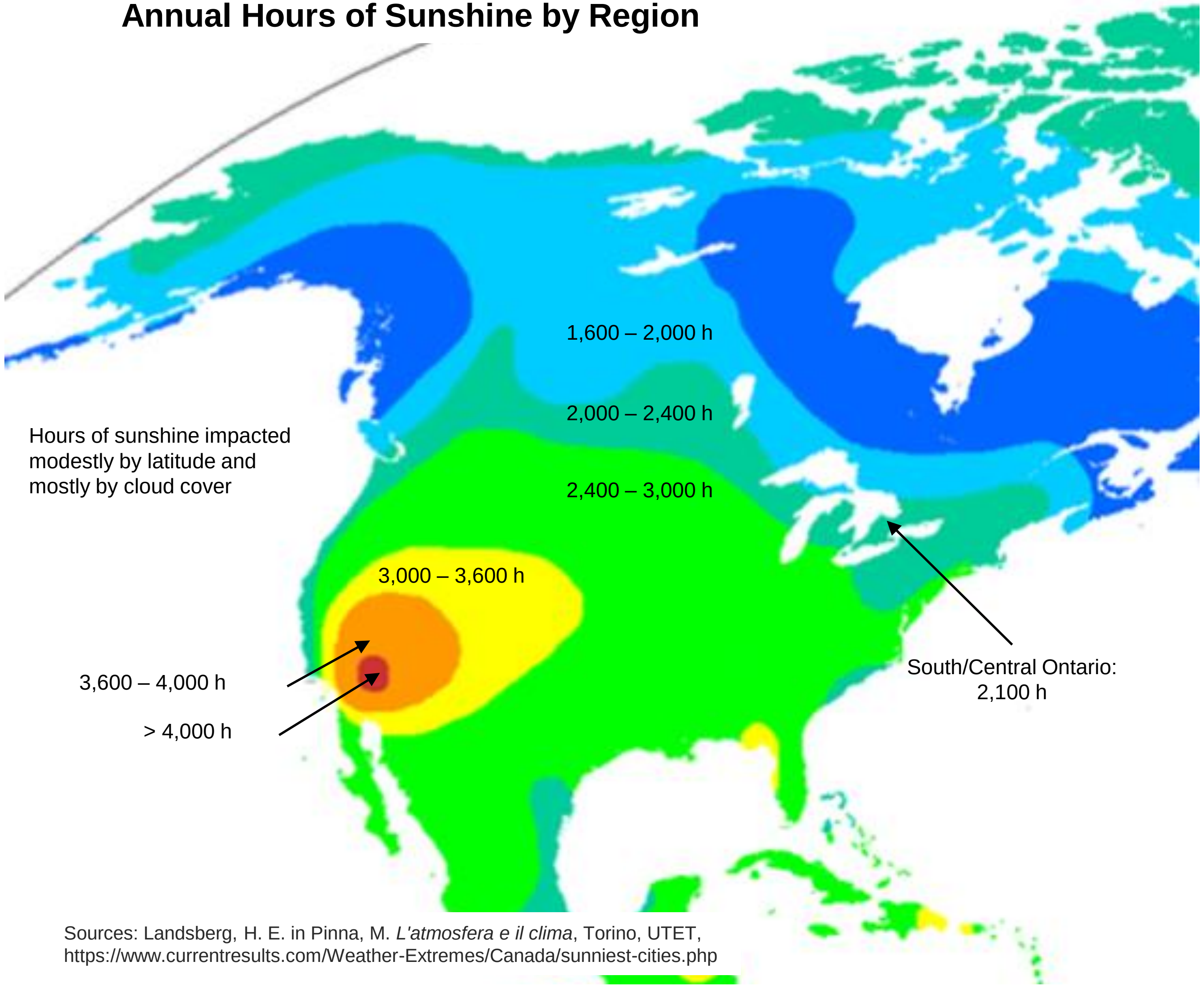
- Can occur at any time
- Doesn't fully charge batteries leaving *unused capacity*
- *Requires backup* to cover shortfall

Backup adds cost

The Unfortunate Truth for Ontario

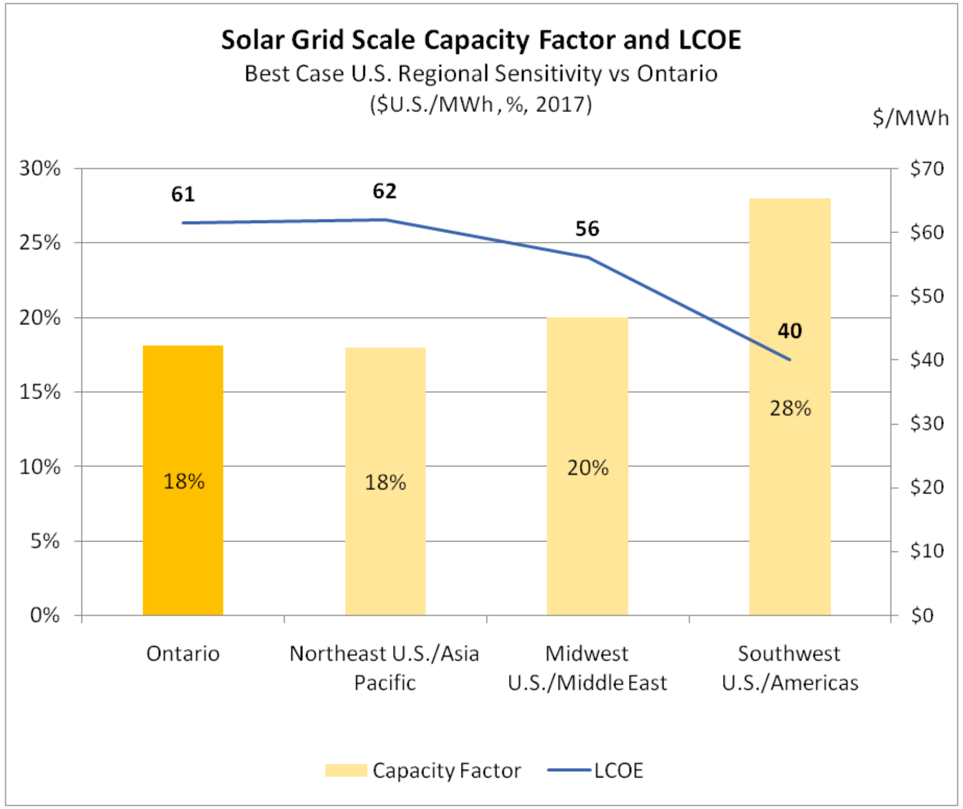
Ontario has far fewer hours of sunshine than the U.S., leading to higher costs for solar

Annual Hours of Sunshine by Region



Sources: Landsberg, H. E. in Pinna, M. *L'atmosfera e il clima*, Torino, UTET, https://www.currentresults.com/Weather-Extremes/Canada/sunniest-cities.php

Ontario and Northeast U.S. Have Highest Cost of Solar

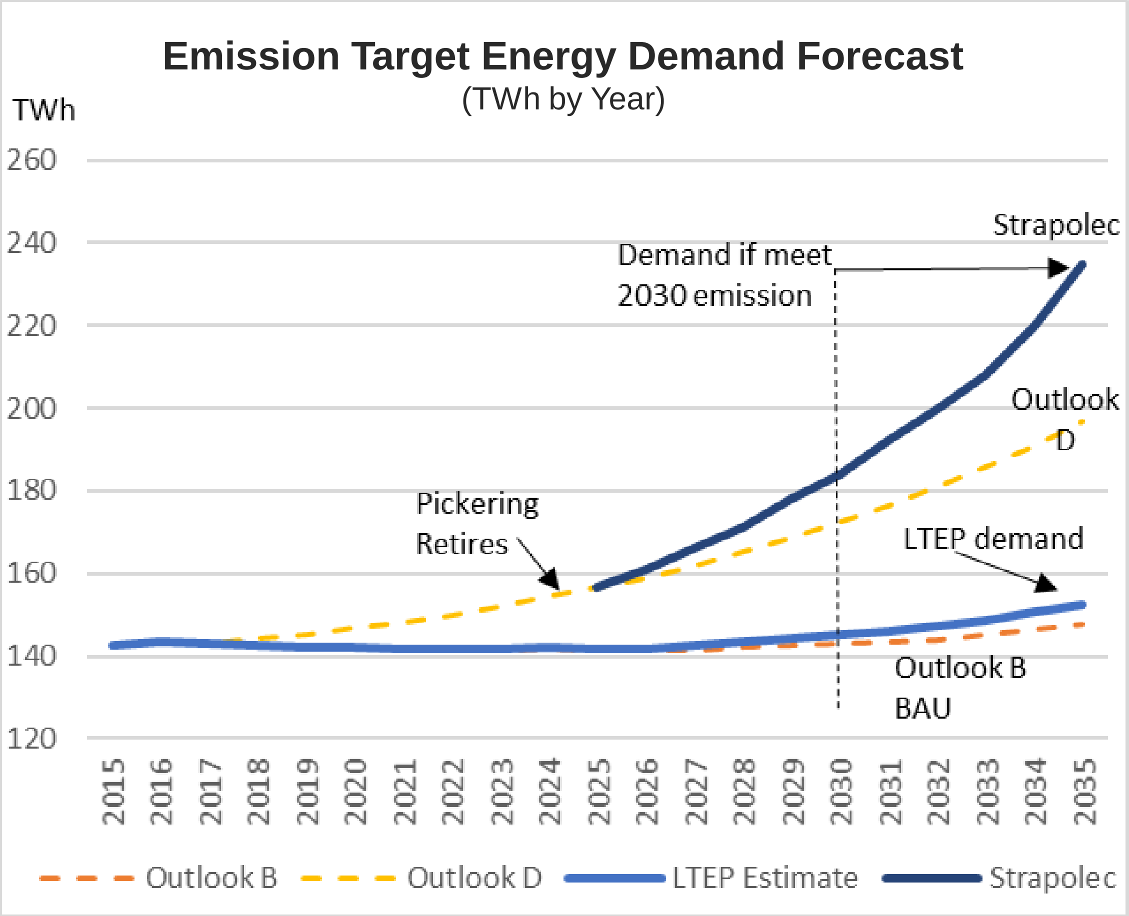


Source: Lazard, IESO actuals, Strapolec analysis

Electrification to Achieve Emission Reduction Increases Demand

Most jurisdictions will not have existing fossil base to be leveraged by new supply

Costs presented based on simulation of low-growth LTEP demand



Outlook B Business as Usual (BAU) and Outlook D from IESO Sept 2016 Ontario Planning Outlook (OPO) released to support the LTEP consultation process with climate related demand scenarios, Strapolec analysis

Electrification Implications

60% more energy required for 2030

- Much of it baseload

Up to two times more for 2050

- Only 30 years from now

This is all new supply

→ a common challenge for the Northeast U.S.

→ Since substantial new demand, there is no fossil system to embed the new supply into

To meet future demand, the full cost of integrated DER solutions should be the comparison