CHANGING LANDSCAPE

From centralized, unidirectional grid …

… to distributed energy and bidirectional energy balancing

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SOLAR PV COST CURVE

GRID PARITY FOR RESIDENTIAL OR COMMERCIAL SOLAR INSTALLATIONS COULD OCCUR IN THE NEXT 5 TO 10 YEARS

Source: Navigant 2016

Impact of more rapid decline in technology costs.
IESO LRP approx. min weighted price range for solar power project.
SYSTEM CONSIDERATIONS

- Load Intensification (Growth)
- Distributed Energy Resources
- Solar PV = Variable Resource
- Interconnection Constraints
LOAD INTENSIFICATION

287 high-rise buildings under construction, proposed or approved for construction in Toronto (+223 existing high-rise)
172MW or 3% DG resources are connected vs. peak load of 5018MW; Forecast rise to 626MW by 2020 or 12%. (Toronto Hydro’s 2015-2019 CIR Rate Application)
SOLAR PV = VARIABLE RESOURCE

Variable renewable output (hourly)

Demand for electricity (after efficiency savings) follows a traditional pattern of increasing throughout the day.

Solar and wind output are variable throughout the day, sometimes exceeding the amount of demand required from customers.

Because electricity supply and demand must be balanced instantaneously, in this simplistic case the excess energy must either be exported to another market, stored, or curtailed. If other generators were providing power, they may be ramped down.

At other times, demand is much higher than the available renewable generation, and demand reduction or additional supply is required.

Rocky Mountain Institute © 2011. For more information see www.RMI.org/ReinventingFire.
INTERCONNECTION CONTRAINTS

Interconnection capacity is related to:

- legacy system design
- short circuit capacity
- thermal capacity
- minimum power flows
- equipment age
- monitoring & control

➤ Address constraints with engineering and resource management with Energy Centre
WHY ARE UTILITIES INTERESTED IN ENERGY STORAGE ASSETS?

- Manage Peak Demand
- Defer Conventional Infrastructure
- Support Power Quality & Resiliency
- Provide Operational Flexibility
- Integrate Renewables
- Support Electric Vehicles & Public Transit
- Provide Ancillary Services

These assets support bi-directional energy flows
MANAGE PEAK DEMAND

- Extends distribution system asset life through reduced loading at high temperatures
- Moderates on-peak pricing for customers by shifting to off-peak charging

HYDROSTOR, 660kW/300kWh, UWCAES
DEFER CONVENTIONAL INFRASTRUCTURE

- Extends distribution system asset life through reduced loading at high temperatures
- Moderates on-peak pricing for customers by shifting to off-peak charging

CECIL TS DR, 4MW/16MWh, Li-Ion Batteries

Station Loading vs. Demand Response Strategy

- Demand Response
- Residential & Commercial "Saver" Programs
- Thermal Storage
- Battery Storage

% of TS Capacity vs. Hours/Year
SUPPORT POWER QUALITY & RESILIENCY

- Provide continuous power conditioning
- Reduce voltage sags, spikes, harmonics
- Buffer supply during generator transfer

- HEALTHCARE, 12MW/3MWh, Li-Ion Batt.
PROVIDE OPERATIONAL FLEXIBILITY

• Manage line & transformer capacity for 2030
• Maintain transfer capacity Manby - Leaside
• Emergency system restoration

☐ 500C Centre, 500kW/500kWh, Li-Ion Batt.

Source: 2015 Central Toronto Integrated Regional Resource Plan (IRRP)
INTEGRATE RENEWABLES

- Integrates grid supply with 75kW solar system
- Buffers variable output of solar system
- Extends service life of 300kVA transformer

- RODING, 250kW/250kWh, Li-Ion Batteries
SUPPORT EV & PUBLIC TRANSIT

- Augment local supply with pole/pad storage
- Accommodate level 3 chargers where needed
- Augment Station supply where needed

MODULES, 30kW/30kWh, Li-Ion Batt.

Source: eCamion
PROVIDE ANCILLARY SERVICES

- Provide voltage/frequency regulation to IESO
- Provide operating reserve to IESO

Toronto Hydro Energy Centre

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Note: Facility auxiliary loads (HVAC, Ltg, etc.) ignored
Toronto Hydro is developing an Energy Centre to provide visibility and enhanced control of resources operating in parallel with our system. The Energy Centre provides monitoring, forecast and control capabilities by extending SCADA points to these resources. This should allow greater penetration of renewables, manage peak demand and provide value to system operators.
Company Overview

- Established in 1911
- Largest municipal electricity distribution company in Canada
- Amalgamation of six utilities in 1998
- Distributes electricity and engages in Conservation and Demand Management activities
- City of Toronto - population over 2.8 million
- Distributes approximately 19% of the electricity consumed in Ontario
- Peak Load: 4,404 MW (August 2015)
- Record Peak: 5,018 MW (July 2006)
Company Overview

- We own and operate $3.0 billion of capital assets.
- 674,201 residential customers.
- 758,000 customers.
- 1,480 employees.
- 81,492 general service customers with monthly demand of 0-5000 kilowatts.
- 44 large users with monthly demand over 5000 kilowatts.
- Head office: 14 Carlton Street, Toronto, Ontario M5B 1K5.
COMPANY OVERVIEW

15,560 km of overhead wires

16,900 primary switches

60,440 distribution transformers

176,500 poles

161 municipal substations

12,920 km of underground wires

Toronto Hydro’s service area
Strategic Focus

Customer | People | Operations | Financial

Energy Storage
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