A Power System Planner's Assessment of Energy Storage

Presentation for OEB Smart Grid Advisory Committee

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Topics

- Types of Storage
- Benefits:
  - Who
  - Opportunities & how to address them
- Some facts
- Perceptions
- Hurdles
- Storage in the Planning Process
- Summary

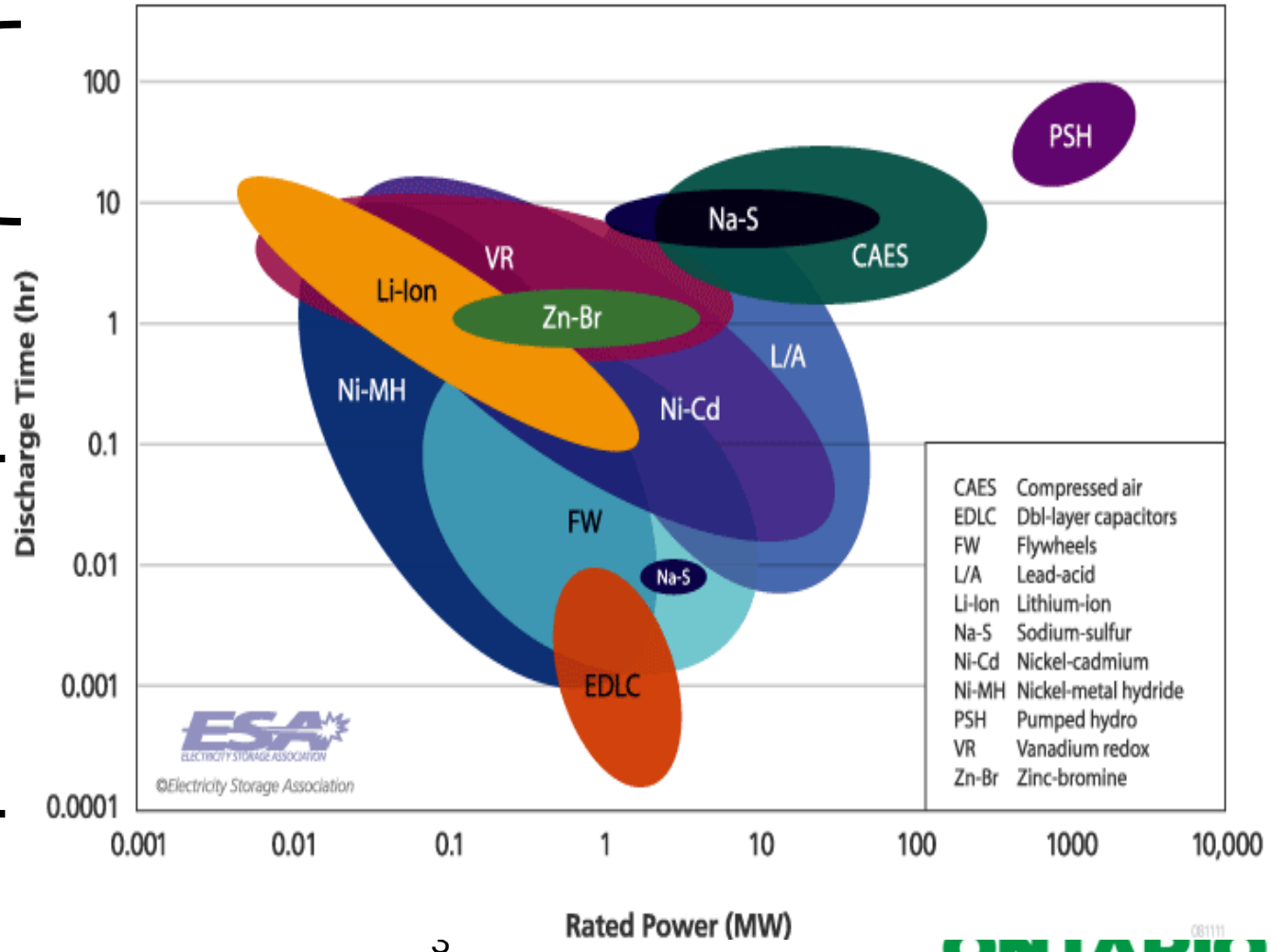
Applications of Electricity Storage - Niches

Storage is not one technology – Many Technologies doing some of many things

Bulk System Storage/ Energy Production Shifting

Distributed Storage/ Renewables Integration

Power Regulation/ Quality Applications (AGC, Voltage support)



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Who Benefits ?

- Developer (Costs + Return)
- Ratepayers (Benefits – other costs) - depends where it is installed
  - **Bulk System** impacts all ratepayers in Ontario
  - **LDC Impacts** LDC customers and potentially other Bulk customers
  - **Individual Customers** and potentially other LDC & Bulk system customers

$$\sum (\text{Net Benefits}) \geq \sum (\text{Costs + Return})$$

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Opportunities for Storage to Provide Benefits

- Capacity Value
  - Generation, Transmission, Distribution
- Energy Production Shifting
  - Arbitrage (hours, days, weeks, seasons)
  - Potential Surplus Energy (PSE) Mitigation
  - Better utilization of renewables (lower emissions?)
- Operating Reserve
- Ramping
  - Renewables Integration
- Power Regulation
  - AGC
- Power Quality
  - Var. Support

What are the Alternatives to Provide Value

A MW of storage is not a MW of storage is not a MW of storage…

BENEFIT	ALTERNATIVES		
	Bulk System	**LDC**	**Customer**
Time shifting	Flatten Load / Price More dispatchable Gen/Load	Flatten Load Dispatchable Load	Flatten Load Dispatchable Load
Surplus Energy	Exports, Load offers, Curtailment	Curtailment of DG	Increas eload
Capacity	SCGT	Wires, substations, transformers, etc.	Rely on LDC to provide capacity
Ramping	Hydro/Thermal	N/A	N/A
Operating Reserve	Hydro/Thermal (market)	N/A	N/A
Power Regulation	Hydro/Thermal (RFP)	N/A	N/A
Power Quality (VARs)	Capacitors (static)	Capacitors (static)	Power Filters
Emissions	Conservation, nuclear, renewables, CHP, CCGT	Conservation, renewables, DG	Conservation, renewables, DG

Which Technology is Better?

- The answer: **It depends**
  - Sorry, there is no simple answer
- Each can have pros and cons
- Niche Applications & Technologies
- Some can be better aggregated than others
- Example: Pumped Hydro Storage – Bulk System
  - What is the cost of peaking generation being displaced?
  - Is the facility in a location requiring Tx system support?
  - Can it take advantage of existing facilities to lower its capital costs?
  - Does not benefit LDC or specific load “customers”
- Example: Ice Storage – Customer
  - Greater LDC benefits if installed in congested service area.
  - Customer benefits greater with larger cost arbitrage
  - Only operates during summer months
- Example: Fly Wheel – Power quality
  - Fast charge/discharge fits into power quality market for some generators (wind/solar) , Tx/Dx, customers

Ontario Energy Storage Pilots

- Toronto Hydro Ice Storage Pilot
  - 12 Ice Bear ice storage units were installed at 8 locations in Toronto Hydro and Veridian Connections service areas for the purpose of collecting and analyzing performance data..
  - Project was funded by the OPA's conservation funds.
- IESO Procurement of Regulation Services from alternative Sources
  - 10 MW procurement program open only to "alternative" providers of regulation services.
  - Successful technologies were flywheels, batteries and demand management.
- Hydro One's Flywheel, Wind Integration Pilot
  - 10 MW of flywheels connected to a Hydro One distribution network to help mitigate voltage fluctuations caused by intermittency in the output of local wind generators.
- And more…

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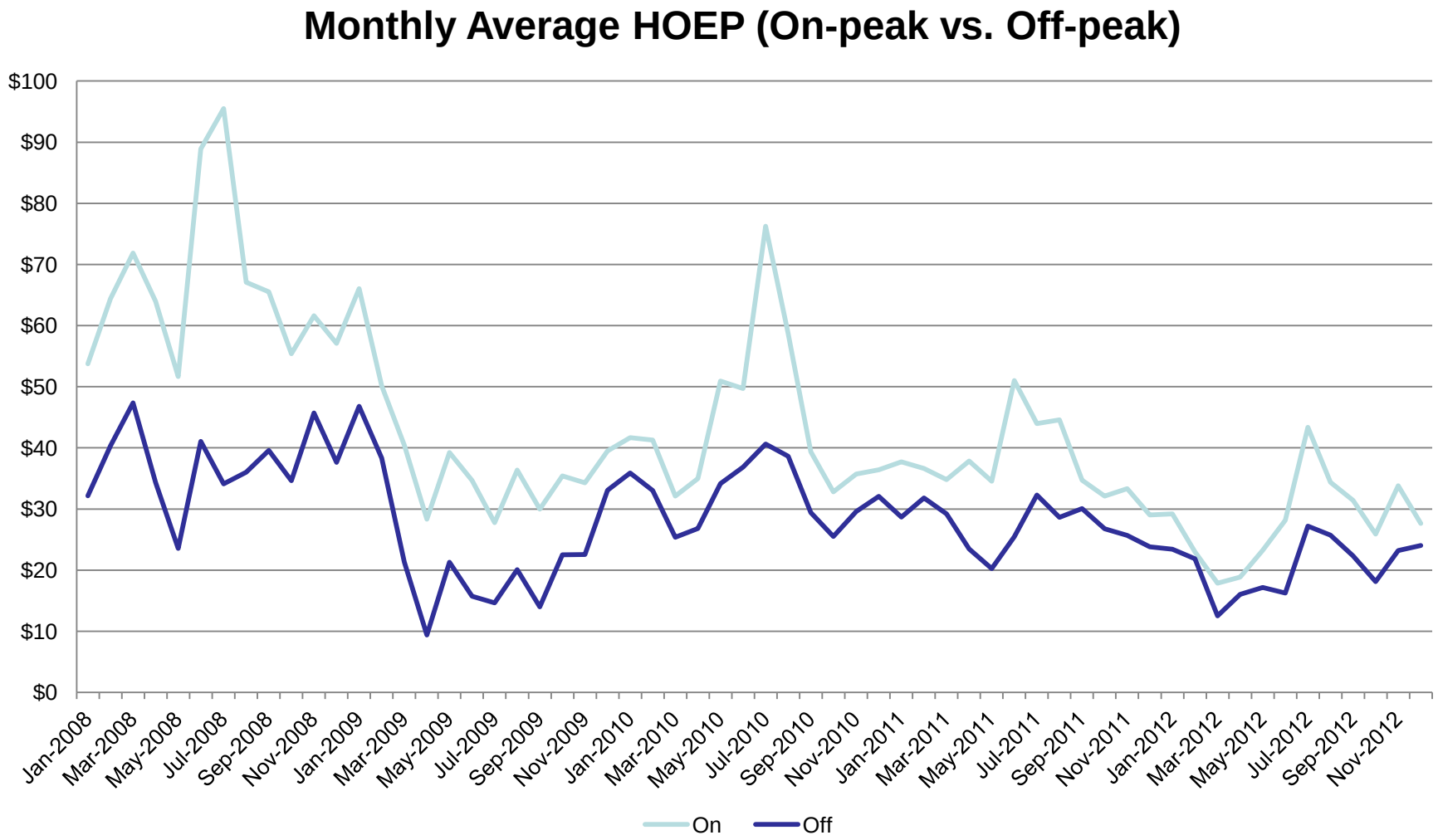
People Say…

- Electricity price arbitrage (e.g. day/night) drives economics
  - In Ontario value from arbitrage is not as large as expected (see HOEP)
- Energy storage can be coupled with Wind Farms to flatten their generation hourly MW output.
  - The volume of storage required to flatten output from a single wind farm is very large
- Energy storage can be applied to absorb energy during times of PSE, and inject the energy later when it's needed
  - PSE is more of a seasonal phenomena (winter vs. summer) and often occurs over multiple days at a time.
  - PSE is in the order of many TWh to be moved between seasons would require very large storage volumes.
- Market/Regulatory barriers what's holding storage back
  - Hurdles in regulatory framework exist and should be addressed

Monthly Average HOEP (On-Peak vs. Off-Peak)



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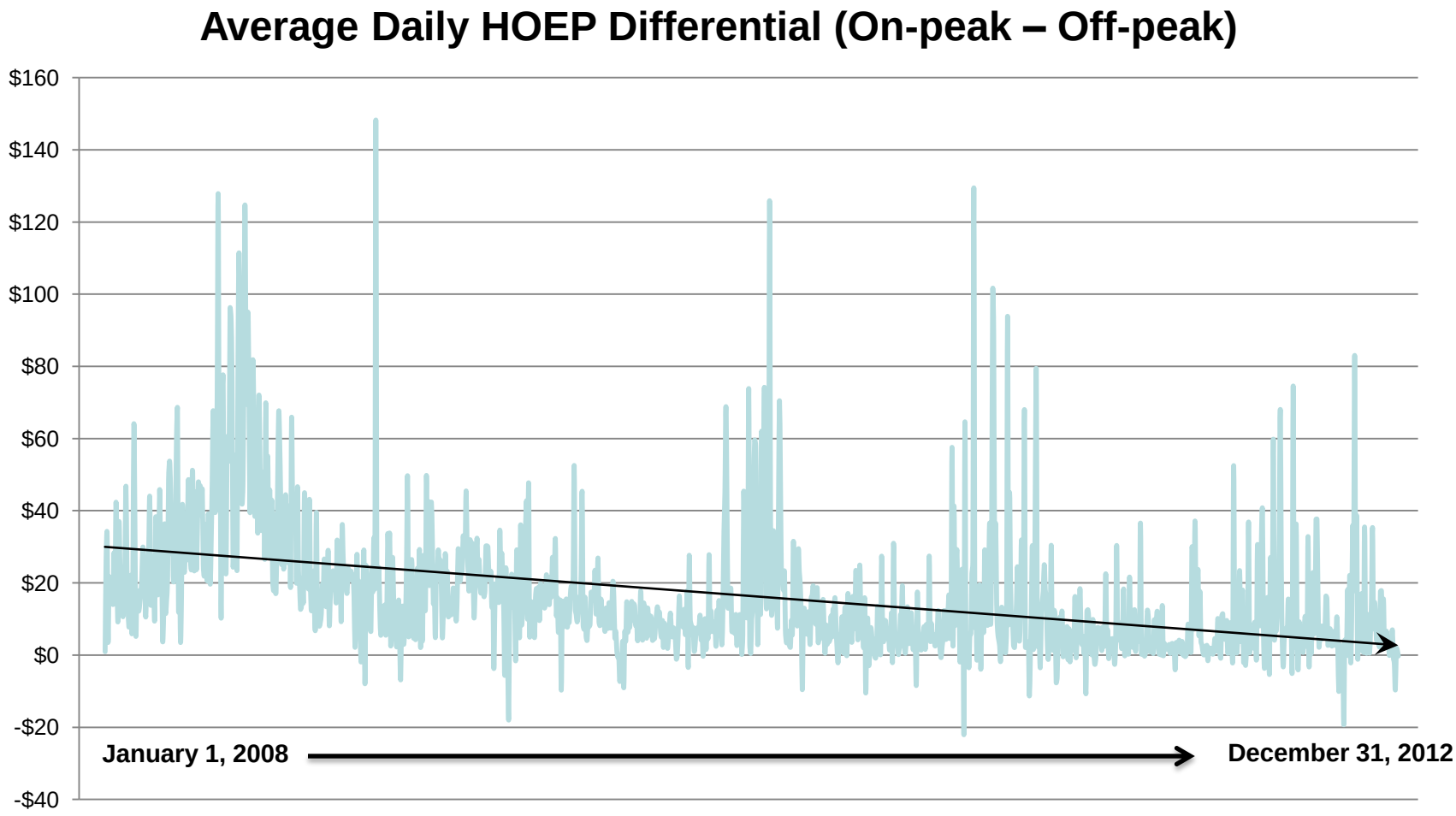
Average Daily HOEP Arbitrage Opportunity



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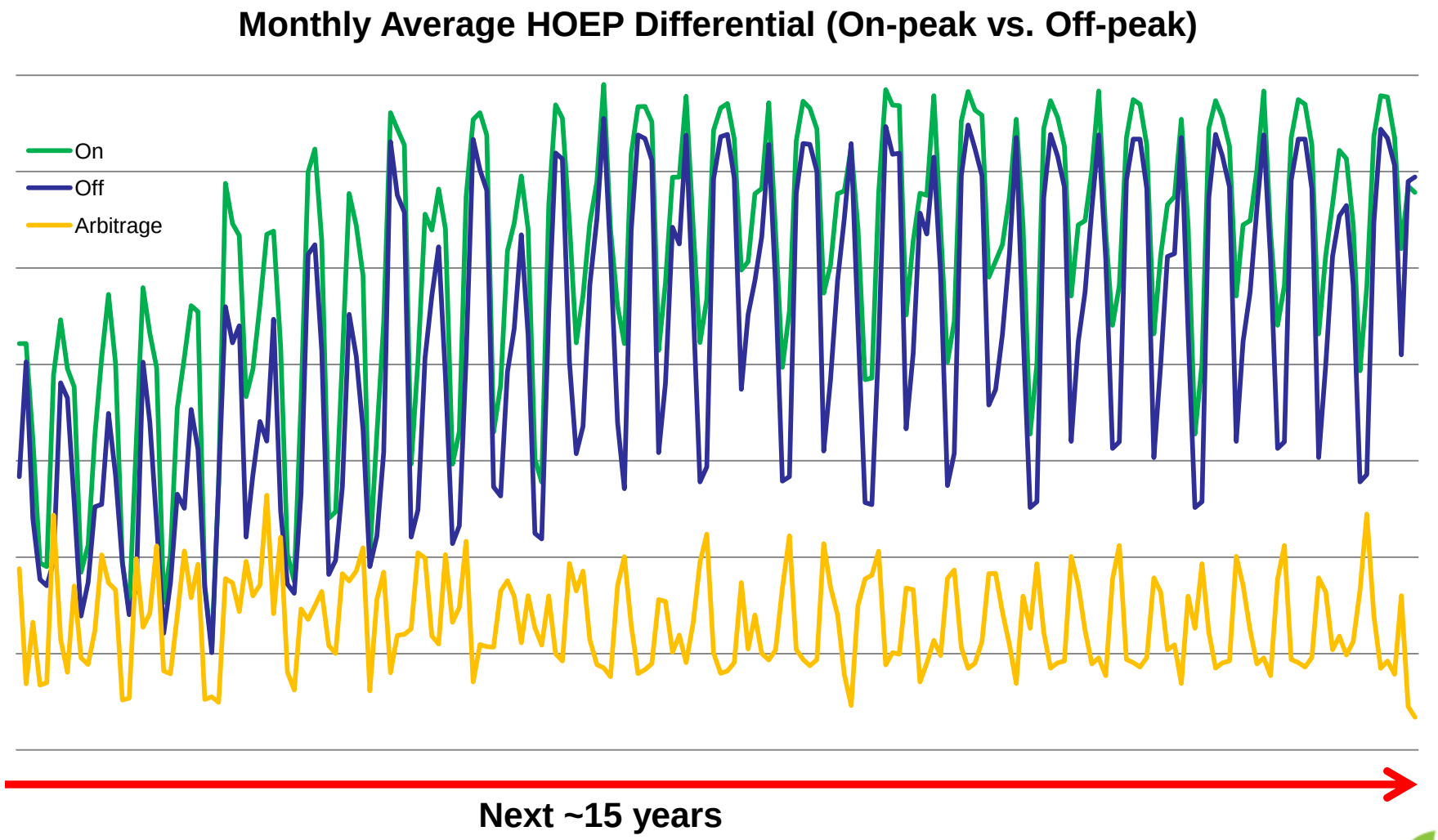
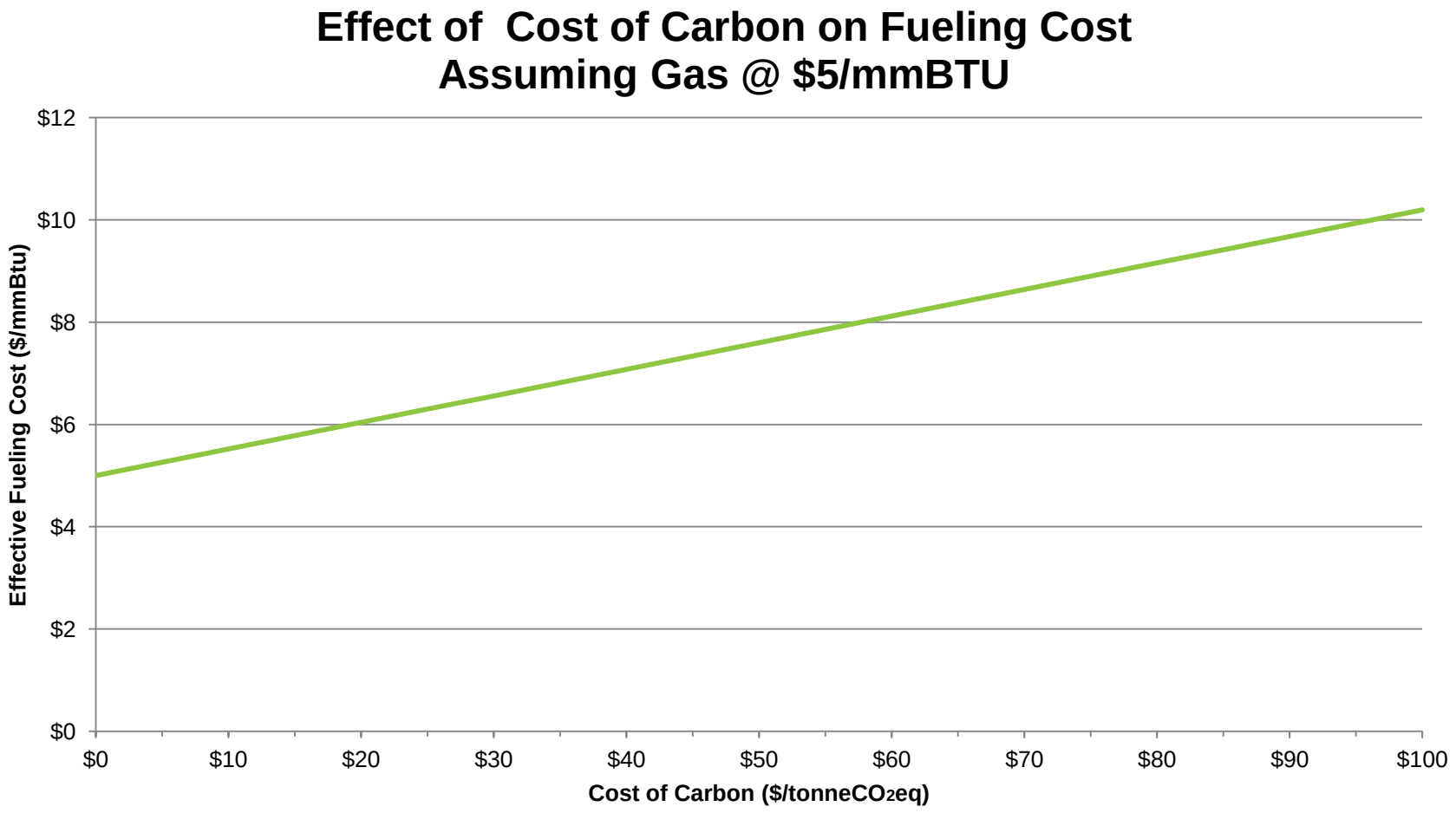
Monthly HOEP Differential is expected to be Small



Effect of Cost of Carbon on Fueling Cost



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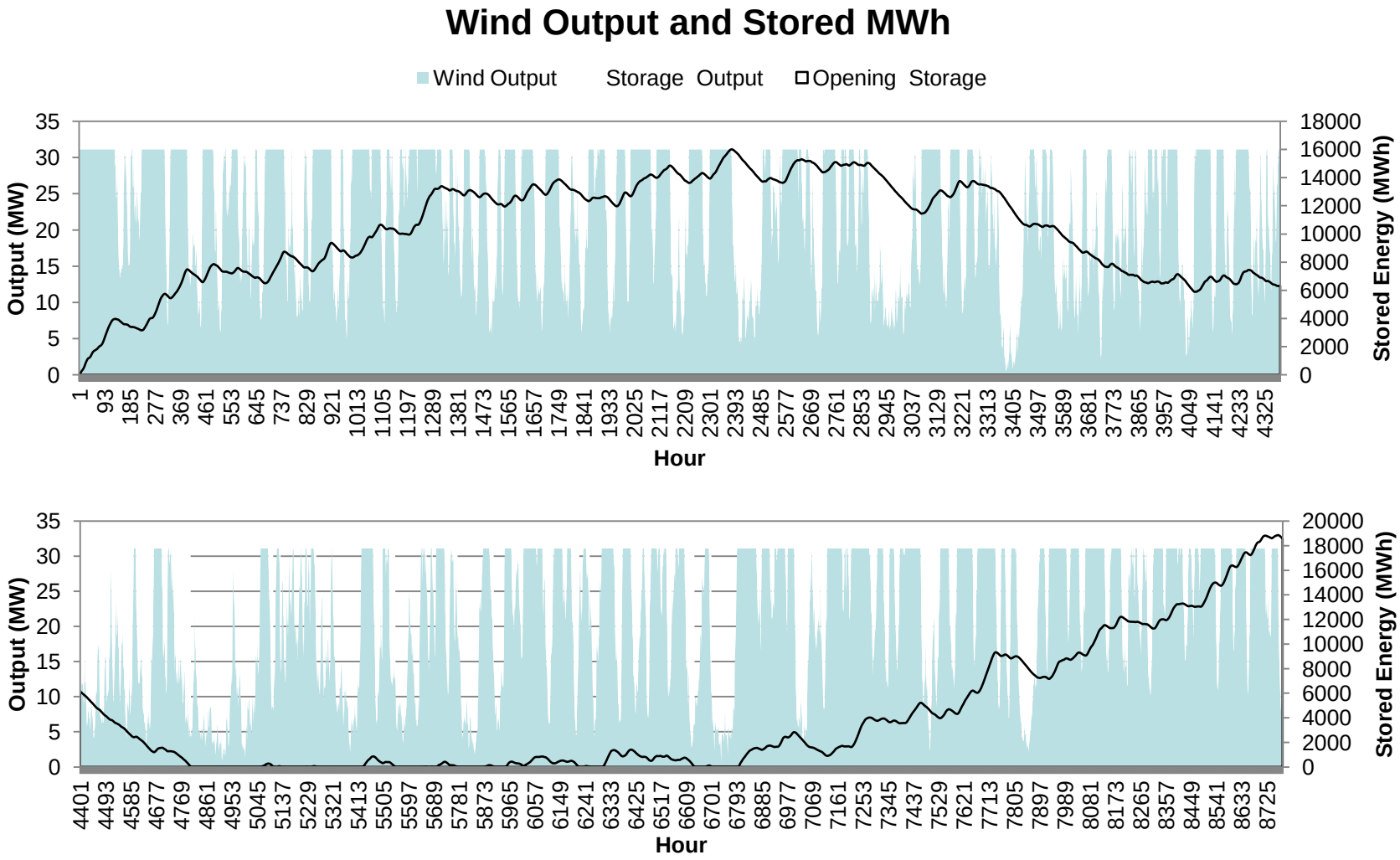
Storing a Year's Worth of Wind



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Incorporating Storage into the Planning Process

- The OPA Identifies a System Need/Opportunities
  - Storage must compete with other technologies to provide max. value
- Optimize The Application to recognize full value of storage
  - Take advantage of existing sites
  - Location, Location, Location…
  - Use existing proposals as well as new ideas
  - Regional planning and “conservation” initiatives are considering LDC/Customer based storage opportunities
- Develop a Business Case
  - Quantify dispersed benefits
  - Recognize that by claiming one benefit can reduce the value of another benefit
  - Realistic look at the return on investment
  - Compare cost/benefit ratio with the other competing technologies
- Address Market/Regulatory Hurdles
  - Address appropriateness GAM, Uplift charges
  - Sharing of benefits

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Contracting Considerations

- Assuming the Business case has been made…
- Many factors must be considered in making a deal
  - Procurement of storage should be value based
    - **Procure only what Ontario <u>needs</u> and only <u>where we need it.</u>**
    - **Payment that reflects value**
  - Discussions with affected stakeholders to determine how costs/benefits are allocated.
    - Which entity is best suited to bear the costs? (LDC, ratepayer, etc.)
    - Are cost sharing agreements a feasible option?
    - How are benefits shared?
  - Storage systems need to be operated efficiently
    - E.g. Some storage technologies need the overall system view as provided by the IESO to provide most effective value.
  - Contracts need to reflect the cost/benefit/risks equations and specify how the facility will be operated

Summary - What's needed to drive Electricity Storage to play a bigger role

- Recognize the various niches and the technologies that fit them
- Need to be cost effective and demonstrate value
- Focus on fact based applications of energy storage and not on perceptions.
- Recognize real value each benefit electricity storage can provide and the interplay and complexities that exist between the benefits.
- Address market barriers and determine ways to optimize collection of the benefits that energy storage provides and reflect these in procurement programs and contracts.
- Keep abreast of Storage technologies' significant technical and cost performance improvements.
- Support early development, piloting, demonstrations, etc., of promising technologies.