# Dispatchable Renewables and Storage: Update to Stakeholders

## Introduction

The AESO thanks all those who submitted a response to our stakeholder questionnaire on dispatchable renewables and storage (DR&S) in Alberta. Each response was reviewed thoroughly and the information received will help inform the AESO's report to the Government of Alberta on how dispatchable renewables and storage could benefit the electricity system.

To gather more in-depth feedback, the AESO also conducted one-to-one discussions with 30+ organizations representing a wide range of interested stakeholders. This document includes a summary of what we heard. The AESO takes no position on any of the comments provided by stakeholders. Participants' identifiable information is kept strictly confidential to protect their privacy.

As requested by the government in its direction letter, the AESO's work will focus on the following:

- What, if anything, is needed on the power system to integrate 30 per cent renewables by 2030, particularly to address any challenges intermittent renewables may bring to the grid
- Determining whether additional specific products or services may be required
- If so, how they should be procured, either through use of existing market mechanisms or via discrete competitions
- If discrete competitions are required, a proposal as to the structure and timeline of such competitions

## Summary of Stakeholder Feedback from Dispatchable Renewables and Energy Storage (DR&S) Questionnaire

A total of 88 survey submissions were received from stakeholders. Due to the dual nature of many submissions, respondents could not be identified within one specific category (e.g., an existing generator also exploring new development opportunities). The list below captures the multiple interests of the various stakeholders that made submissions.

### Respondents/Participants

- 59 developers/investors
- 20 power industry (generators, transmission/distribution owners, others)
- 13 interested parties
- 8 unidentified
- 8 supply/support chain
- 4 associations/organizations

The AESO has summarized the feedback received from stakeholders into the following sections:

1) Need for DR&S in Alberta
2) Role of DR&S
3) Technology–Specific Feedback
4) Barriers to DR&S
5) Pros and Cons of DR&S Development
6) Other Jurisdictions: Learning Opportunities
7) Additional Stakeholder Comments

## 1. Need for DR&S in Alberta

Stakeholders indicated a broad range of experience, identifying projects developed around the globe and across a full spectrum of DR&S technologies. Project developments included numerous storage projects, either co-located with wind or solar generation or as standalone assets. Many had already achieved success in developing or owning battery storage projects, at both small-scale and utility-scale. Hydroelectric and biomass generation were also among the asset classes developed by respondents.

A number of key themes around the need for DR&S emerged from the survey responses:

### *Supporting Grid Evolution*

- The evolving grid must accommodate a diversity of DR&S technologies, not just wind and solar
- DR&S will help the provincial power sector to evolve as an efficient, sustainable and environmentally responsible entity; an opportunity for Alberta to show global leadership
- More diverse generation mix will maximize progress toward Alberta's sustainable energy goals
- Supports efforts to help achieve provincial and national emissions reduction targets; can also prevent gas from becoming Alberta's 'new coal'
- DR&S will become a critical component of ensuring grid reliability
- DR&S can allow deferral of transmission and distribution investments
- Provides targeted deployment to support grid transformation
- Provides consumer benefits: reduced energy costs, price stability; improved reliability
- DR&S will maximize value of investments in renewable assets, especially when paired with storage

## 2. Role of DR&S

- Improved grid operational flexibility, resilience, stability and level of control (time-shifting capability)
- Transmission optimization; improved efficiency, congestion management, maintaining power quality
- Multi-purpose assets that can respond to fast variations, regulate power quality
- DR&S can deliver a broad range of services:
    - Voltage and frequency management
    - Dynamic reactive power support
    - Reactive power support at low voltages
    - Reactive power support on individual phases
    - Fast-ramping capability
    - Fast response to regulating reserve
    - Spinning reserve and ancillary services markets
    - Black start and transmission-must-run services
- Co-located storage + solar will support variable generator capacity firming; variable generator ramping service; variable generator smoothing; curtailment mitigation; peaking capacity; VAR support; peak shaving
- Could encourage advancement of biomass technology; could create new revenue streams for forestry and agricultural sectors, and alternatives for landfill management

- Storage will keep consumer costs low by absorbing excess renewable generation
- Storage = improved consistency of overall generation profile; will prevent curtailments of wind/solar
- Could encourage advancement of pumped hydro development
- DR may be required to backstop thermal generation if gas prices spike or gas supplies are curtailed

## 3. Technology–Specific Feedback

The following summarizes common responses/themes; grouped by technology:

### *Storage proponents (battery, compressed air energy storage, pumped hydro)*

- AESO may need to direct storage to locate near DR to maximize benefits
- Storage could reduce/defer need for hydro development
- Storage can provide fast response to regulating reserve, spinning reserve and ancillary services markets; also black start and transmission-must-run services
- Storage will encourage increased development of microgeneration
- Storage should be considered in Renewable Electricity Program (REP) procurements
- Storage is an alternative to traditional wires-based solutions on distribution system
- Storage will prevent need to 'waste' energy by exporting power at distress prices
- Storage optimizes non-flexible thermal generation (e.g., cogeneration) by preventing sub-optimal operation that increases emissions per unit of generation
- Need market-based incentives to enable storage to deliver variety of grid services
- Pumped hydro provides higher cost/benefit value than battery; best opportunity for local downstream economic benefits (construction services, supply chain, etc.)
- Batteries should be considered to 'flatten' intermittency of renewables
- Battery storage is a modular resource; smaller amounts of capacity can be added as needed to meet evolving grid needs; can be co-located or sited at areas of highest need
- Pumped hydro is an excellent solution to ensuring fast ramping and dispatchability are covered during transition to renewables
- Strategic storage placement could eliminate need for capacitor banks, SVC, STATCOM elsewhere
- Storage increases hosting capacity of distributed energy resources (DER) on a distribution system
- Rules must allow storage to compete on a level field with new gas generation
- Storage is only asset class capable of mitigating oversupply and reducing curtailment of intermittent renewables; AESO should prevent oversupply situations by starting a procurement process now
- Pumped hydro should advance now as long lead times are involved
- Flexibility of storage can replace need for peaking gas assets
- Co-located storage + solar will support variable generator capacity firming; variable generator ramping service; variable generator smoothing; curtailment mitigation; peaking capacity; VAR support; peak shaving
- Co-location of solar + storage is more efficient and cost-effective than locating units separately
- Storage + DR will allow higher levels of integration with better grid performance
- Aggregation of multiple DER with co-located storage offers opportunity to harness consumer-level generation

### *Generation proponents (solar, wind, hydro, biomass)*

- Biomass and biogas development as baseload; reduces need for gas-fired assets
- Growth of biomass will create new revenue streams for forestry and agriculture sectors, and alternatives for landfill management
- Run-of-river hydro should incorporate some degree of storage capacity
- Solar DER is most manageable form of DR for distribution facility owners
- Without dispatchability, new renewable assets will just be offsetting/curtailing existing ones or facilitating exports

- B.C.-based hydro should be considered as part of a DR solution
- Hourly/monthly solar production curves align well with Alberta demand load for most of the year; reduces size of storage component required
- DR is an absolute necessity to avoid intermittency issues
- Small-scale solar DER an option for large urban areas
- Footprint of utility-scale solar makes poor use of prime agricultural lands
- Time-of-use metering would incentivize solar development
- Solar offers some desirable dispatch components (e.g., frequency regulation, daytime peak matching)
- No systematic effort being made to assess Alberta's hydroelectric potential
- Biomass is not widely recognized in Alberta despite abundant feedstock from forestry operations; too much focus on wind/solar
- Anticipated large renewables footprint will require fast-ramping DR to meet intermittency challenge
- Public enthusiasm for renewables may decline if extensive integration causes operational issues impacting reliability or supply adequacy
- In Europe, wind and solar dispatches on two-day look-ahead with 90 per cent probability
- As DER penetration increases, DR can be used to manage voltage, frequency, and reactive and real power flows on the distribution system
- Widespread integration of DR can cause significant transmission congestion, resulting in negative pricing and curtailments – presents major risk to developers and investors
- Price signals should adequately manage the addition of new DR; currently no need for DR as market signals are not incenting new gas-fired facilities

### *Emerging and commercial technologies*

There were several comments regarding emerging or early commercially viable technologies to consider:

- Centralized fusion technology – for large urban areas
- Geothermal
- Kinetic energy storage
- Flow batteries
- Flywheel
- Hydrogen/fuel cells
- Pumped heat electrical storage (PHES)
- Residential wind turbines
- Cogeneration facilities sized for dispatchable export volume
- Lithium ion batteries
- Bioenergy – anaerobic digestion, landfill gas
- Electric vehicle charging stations
- Gravity batteries
- Waste heat from industrial processes
- Combined heat and power (CHP)
- Small modular nuclear reactors
- Installation of storage within load-serving entities (LSE) such as municipal distribution networks, and in support of transmission-connected commercial/industrial customers, allows LSE to become dispatchable loads

## 4. Barriers to DR&S

The following are common responses and themes, grouped by category, for barriers to DR&S:

### *Regulatory and governance*

- Need for improved regulatory certainty on longevity of DTS charges and rules
- Regulatory risk: protracted, confusing, unclear regulatory process
- Regulatory process has too many unknowns regarding storage
- Existing AESO Rules written for thermal generation; need upgrading
- AESO Rules for storage lack clarity
- Lack of provincial legislation addressing storage
- Needs to be a fast-track regulatory process for quiet, non-emitting sources such as battery storage, especially if procurement is via a competitive process
- Multiple interconnecting processes: AUC, AESO, Alberta Energy Regulator (AER), Alberta Environment and Parks (AEP), municipal governments

### *Markets*

- Limited revenue opportunities
- Investors lack confidence and clarity on revenue streams
- Financing challenges (e.g., need for long-term offtake structures to provide revenue certainty)
- Lack of long-term, investment-grade contracting opportunities
- Some investors holding off until rapid pace of tech advancements slows (risk of obsolete assets)
- Overall uncertainty about success of new capacity market and/or ancillary services market
- Ancillary services market is very small and dominated by a single player
- Market share controlled by incumbent generating sources
- Incumbent generators are most influential advisors to AESO; work to stifle competition and entrench old assets/models
- Capacity market design may impede deployment of non-subsidized renewables
- Uncertainty around coal retirement schedule and transition process
- Historic treatment of small developers in Alberta power sector
- Lack of comprehensive development plan for hydro
- Lack of funding for technology and prototype development, demo projects
- Lack of familiarity with suppliers
- Long-lead projects (i.e., hydro) require different procurement model and longer offtake agreements

### *Technology*

- No recognition/monetization of value of specific attributes of renewables
- Typical entry-level barriers encountered by all new technologies; some successful demo projects always needed to accelerate the integration
- Shortage of qualified labour pool for unfamiliar technologies
- Lack of understanding of biomass' specific benefits
- Technical challenges specific to technology type (e.g., scalability of battery storage)
- Current design of storage tariffs, required to pay wires fees when both charging/discharging
- Ability to capture full value of storage; can perform multiple functions beyond time shifting; need market mechanisms to unlock this value
- Lack of Alberta lender experience/comfort with storage technologies
- AESO views storage as a system burden rather than an asset; not part of planning framework

## 5. Pros and Cons of DR&S Development

Common responses and themes are summarized and grouped by category:

### *'Pro' comments*

- Adds flexibility, resilience and efficiency; improves power quality, stability/reliability, grid optimization
- Rapid deployment; can right-size solutions as needed
- Greater variety of assets responding to periods of stress
- Reduces need for asset redundancy, building capacity to address intermittent renewables
- Creates downward pressure on prices; benefits consumers
- Abundant wind/solar resources here
- Would ensure integrity of energy prices within each hour and optimize overall cost of supply in go-forward market
- Supports '30 by 30' and emissions reduction policy goals
- Can be achieved using Alberta businesses and expertise
- Reduced need for transmission upgrades
- Will decrease our reliance on fossil fuels and reduce emissions; renewables should always receive priority regardless of price or cost
- DR&S development gives new technologies an opportunity to gain a foothold
- Greater variety of technologies in supply mix increases diversification of job opportunities
- Solar offers predictable daytime production profiles when paired with satellite/radar weather imaging/mapping
- Pumped hydro is an established technology; carries no new-tech risk; fast-ramping with long discharge time (8+ hours)
- Solar PV offers fastest capacitor-based dispatch capability; daytime peak matching with Alberta loads corresponds well to predictable solar outputs
- Solar is a perfect generation spectrum fit with oilsands cogeneration
- A more dispatchable fleet of renewables (via storage) will slow the build-out of gas-fired generation and reduce the long-term risk of stranded gas-fired assets
- Storage is highly flexible, provides value across supply chain regardless of supply mix
- Storage provides non-wires alternative to poles-and-wire approach to mitigating system deficiencies
- Thoughtful locating of battery storage within high-density urban areas can provide quick short-term response when needed
- Higher possibility of integration into Distributed Energy Resource Management System (DERMS) to manage and optimize DER
- Virtually no 'cons' to DR&S except that current prices are lower than generation cost
- Any policy/procurement design should allow for rapid cost and technology advancements

### *'Con' comments*

- Developers will only incorporate storage if its value to the grid can be reliably monetized; fair market structures will attract investment
- Initial financial stimulus may be required; potential for political risk
- Regulation and policy amendments required
- Rapidly declining costs creates uncertainty for longer-term commitments
- Cost of some technologies (e.g., pumped storage) require huge, long-term investments; could result in stranded assets that don't evolve with the system
- Concerns about dampening price signals and distortion of markets
- Some risk involved in integrating new/emerging technologies
- Integration presents new planning and operational challenges for AESO
- Government needs to continue programs to ensure effective and timely development of technologies in order to achieve policy goals

- Increased integration of renewables increases risk of curtailments; storage is the solution
- DR&S should be implemented when technologies reach economic and technical parity
- Building a combination DR&S projects increases cost, incurs conversion/storage losses
- Requires sophisticated connection analysis to encourage flexible projects to connect
- Wind/solar needs storage component to achieve dispatchability; biomass needs no additional infrastructure (i.e., storage) to achieve baseload
- May have impact on prices, primarily affecting large-load industrial customers
- Biomass is typically baseload and would require coordinated demand response to become dispatchable; a capital-intensive asset that takes longer to build
- Co-location of DR and storage does not guarantee optimization, so non-co-located assets should be considered
- A dispatchability requirement will make building renewable assets more costly, but make them conform to same technical requirements and dispatch rules as other generators
- DR&S will complement supply, but complicate market rules for selling electricity
- Reliability and longevity of storage batteries may still be an issue
- Integration of new technologies could cause disruption of market framework and grid operation, but also synergies and benefits

## 6. Other Jurisdictions: Learning Opportunities

Participants suggested a wide range of jurisdictions to consider learning from. Those most frequently identified are listed below.

- New England Independent System Operator (NE–ISO)
- PJM Interconnected
- New York Independent System Operator (NY–ISO)
- Electric Reliability Council of Texas (ERCOT)
- United States (general)
- California
- Hawaii
- Arizona
- New York
- Massachusetts
- European Union (general)
- Germany
- United Kingdom
- Ireland
- Australia
- Ontario
- British Columbia

## 7. Additional Stakeholder Comments

Respondents provided additional insightful comments, observations and suggestions. These are summarized and grouped by category:

### *Policy development and system planning*

- Alberta has an opportunity to be a Canadian leader in renewables penetration while providing low-cost power to consumers
- Alberta's '30 by 30' target is lower than many American states; still plenty of room for renewables in our generation mix
- AESO should account for DR&S outside of the 5,000 MW REP procurement target

- Cost/benefit of DR&S should be evaluated against emerging technologies before moving forward
- AESO must be very clear on what specific DR attributes it is looking for
- Any policy design should create a runway for the most competitive solutions, not pick winners
- REP could be increased to allow greater DR penetration, mitigate 'dash to gas'
- Need to apply fairness across all generation types in creating a sustainable grid; none should receive subsidies or other preferential treatment
- Allow technology to develop naturally to meet market needs rather than in a mandated fashion
- Capacity market design and Climate Leadership Plan provide the path forward; no further changes are needed to ensure Albertans are well served and investors are confident they can compete
- Procurement for paired DR&S and non-paired but aggregated renewable/storage should proceed as quickly as possible; also need standalone procurements for short-duration storage and long-duration bulk storage (minimum six hours)
- Any DR&S procurement must consider all technologies, avoid over-supply
- Essential to have realistic information on probable magnitude and cost of all long-term renewable electric power alternatives in order to plan Alberta's power system long term
- Evaluation of DR&S must consider time of delivery and firm capacity value

### *Market*

- Storage, interties and demand response are critical elements of a cost-optimized market
- Creating incentives via real-time price signals will create the competitive outcomes; contracting for renewables via auction process does not foster a fair, efficient, openly competitive market
- AESO should remain technology agnostic and allow economics/market forces to dictate outcomes; 'pros' of incenting otherwise uneconomic generation are far outweighed by 'cons' including distortion of price signals, undermining of market constructs, increased investor uncertainty
- Merchant power sales are not financeable; long-term offtake contracts are required whether asset is dispatchable or not

### *Generation*

- Hydro provides stable, long-term baseload at competitive cost, ramping ability and storage – this solution must not be ignored; need further study of development options for each of 60 sites identified in 2010 Hatch report (commissioned by Alberta Utilities Commission)
- Biomass has huge potential and should not be sidelined by other technologies
- Pumped storage will be much more expensive than wind/solar/battery alternatives in Alberta market
- Recommend investigating combined thermal-plus-storage systems
- Large-scale development of gas generation will eventually create legacy liabilities as DR&S technologies advance rapidly and displace them

### *Storage*

- Must ensure that storage projects can effectively unlock variety of value streams including: peak shifting, demand response, frequency/voltage regulation, capacity market
- AESO should consider piloting a grid-connected storage project to understand how it will behave in the Alberta context
- Storage is not immediately required for reliability, but market mechanisms should be established now as DR&S penetration increases
- AESO should host an energy storage symposium