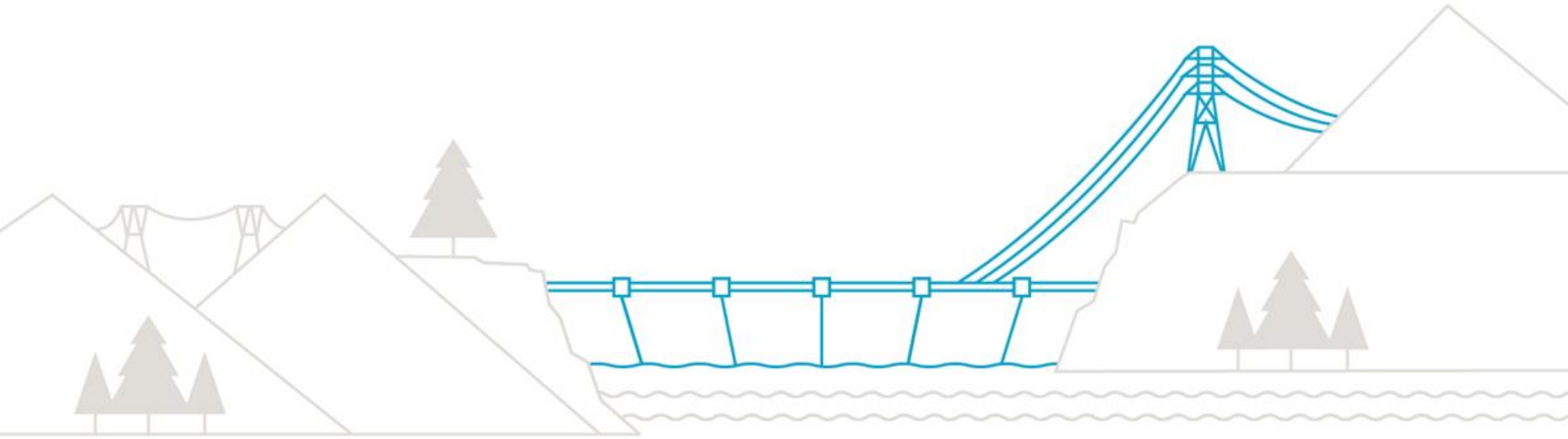
Integrated Resource Plan
Technical Advisory Committee

Meeting – March 8, 2017



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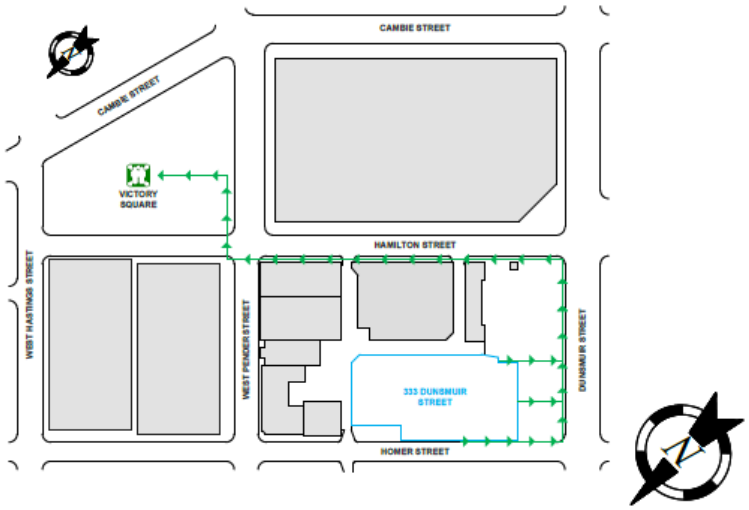
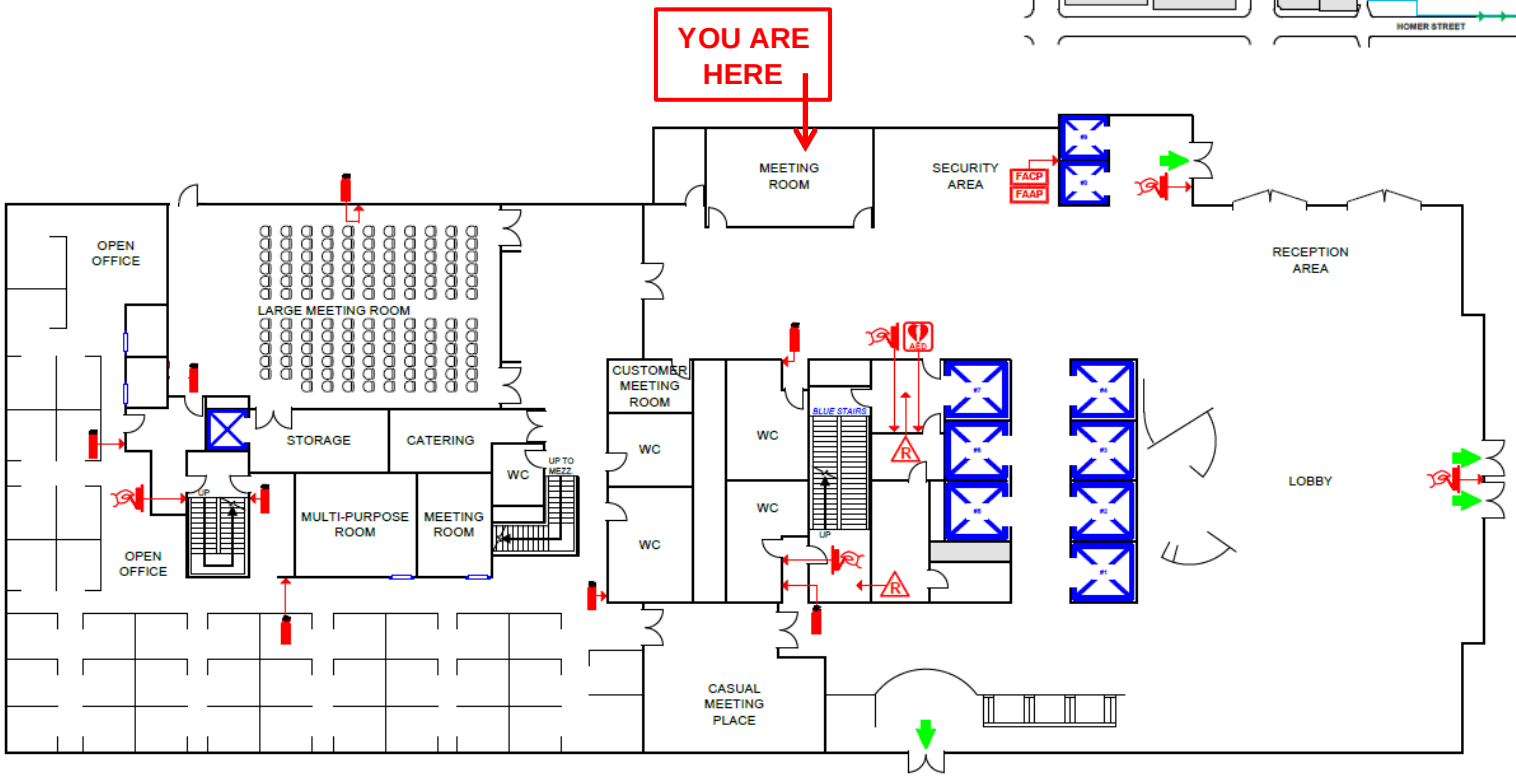
Safety

- Muster location: Victory Square
- Emergency exits: Doors on the main floor are located in the lobby – east, south, west

Map to Victory Square





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Meeting Agenda

Time	Item	Presenter
9:00 – 9:20	Welcome & Agenda Review Draft Terms of Reference	Anne Wilson / Randy Reimann
9:20 – 10:30	Scenario Planning	Randy Reimann / Sanjaya De Zoysa
10:30 – 10:45	Break	
10:45 – 11:45	IRP Key Questions & Work Plan Highlights	Kathy Lee
11:45 – 12:00	Close & Next Steps	Anne Wilson

Integrated Resource Plan

Our long-term plan for the integrated system to meet future electricity demand

- Guiding policy is the ***Clean Energy Act***, which prescribes requirements for self sufficiency and 16 energy objectives, including:
  - Maintain at least 93% clean generation (Climate Leadership Plan mandates 100% clean going forward unless reliability/cost concern)
  - Reduce expected increase in demand by at least 66% through demand-side management by 2020
  - Reduce GHG emissions in B.C.
  - Foster First Nations / communities economic development
  - Ensure rates remain amongst the most competitive in North America

- Required by the ***Clean Energy Act***, IRP is to be updated and submitted to government for approval at least every 5 years
  - **2013 approved IRP**
  - **2018 IRP**

Draft IRP TAC Terms of Reference

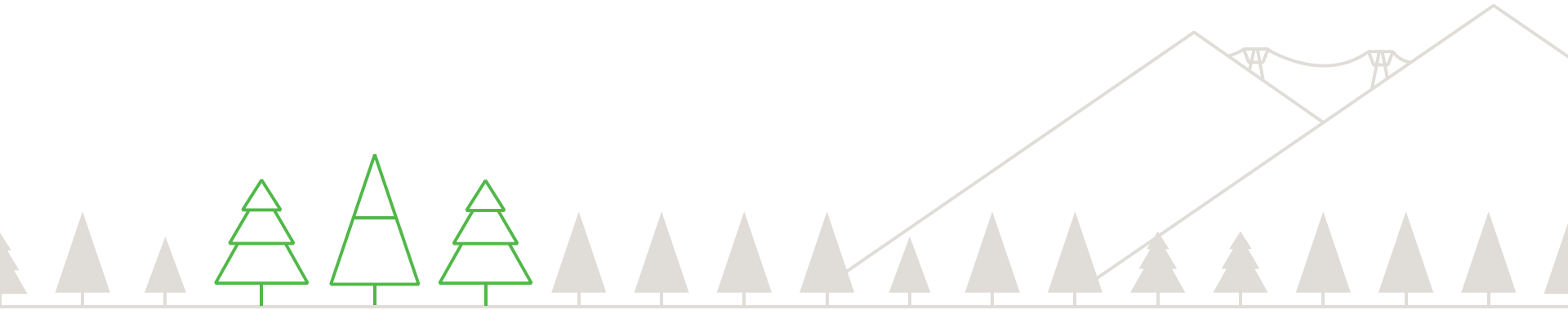
Contents and Key Features

- Mandate
- Membership and Roles
- Responsibilities of Members
- Responsibilities of BC Hydro
- Process Management
  - Meetings
    Periodic as per work plan (anticipate ~6-8 meetings by November 2018)
  - Meeting Notes
    Summary level
  - Transparency
    Materials posted as part of engagement record
  - Committee Member Comments
    At junctures, attributed submissions requested
  - Participant Funding
    Available for eligible members

Recap from last meeting

- **Met in October 2016:**
  - Provided an update on the Revenue Requirements Application and Load Resource Balance
  - Communicated and discussed outcomes of the review of 2013 IRP
  - Looked ahead to 2018 IRP
- **Feedback received regarding 2018 IRP scoping:**
  - Look at scenarios – game changing
  - Start early on new (planning) process
  - Address technology advancement (solar, EVs, storage)
  - Demand-side management scope and metrics
  - Involve First Nations early
  - Consider climate change
  - Scenarios need to consider energy and GHG emissions
  - North east electrification
  - Invite cities/municipalities to TAC
  - Tariff issues around net metering (rate design topic)

Scenario Planning



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Scenario Planning

What is it?

- Scenarios are stories about how the future might unfold for our world and our issues.
- Scenarios are not predictions, they are created and used in sets of multiple stories which capture a range of future possibilities, good and bad, expected and surprising.
- Scenarios are designed to stretch our thinking about the opportunities and threats that the future might hold, and to weigh those opportunities and threats carefully when making long term strategic decisions.

2018 IRP Key Considerations

Our planning environment continues to evolve, with new uncertainties and potential paradigm shifts

As part of the 2018 IRP, BC Hydro will explore future worlds (scenarios) that will provide the context for planning within the company

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Technology Advancements

"Clean Disruption projections (based on technology cost curves, business model innovation as well as product innovation) show that by 2030 all new energy will be provided by solar or wind."

– Tony Seba, Author and Thought Leader

"The great hope for a quick and sweeping transition to renewable energy is wishful thinking"

– Vaclav Smil, Author and Professor at University of Manitoba

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Climate Change Policies

Utility DIVE Home Events Library Jobs Viewpoints

Generation T&D Solar Storage Demand Response Distributed Energy Re

BRIEF

Reports: Trump to issue order rolling back Clean Power Plan next week

AUTHOR
Robert Walton
@TeamWetDog

PUBLISHED
March 2, 2017

Dive Brief:

- President Trump is expected to issue orders next week that will begin the process of striking the Clean Power Plan and ending a moratorium on new coal mining on federal lands.
- The move to roll back the Obama administration's signature climate initiative has been widely expected, but other actions have so far come first. This week, Trump signed executive order directing the U.S. Environmental Protection Agency to reconsider a controversial water protection rule.
- Additionally, CNN reports it has new details on cuts expected at the EPA. The news outlet says more than a dozen greenhouse gas programs could be eliminated under Trump's budget proposal to Congress.

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The Government of Canada accelerates investments in clean electricity

News Release

Environment and Climate Change Canada | Environnement et Changement climatique Canada

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The Government of Canada accelerates investments in clean electricity

November 21, 2016 - Ottawa, Ontario – Office of the Minister of Environment and Climate Change

Today, the Honourable Catherine McKenna, Minister of Environment and Climate Change, announced an important part of the vision for a clean-growth economy: the acceleration of the transition from traditional coal power to clean energy by 2030. Traditional coal-fired electricity does not use carbon capture and storage to trap carbon dioxide and store it.

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Examples

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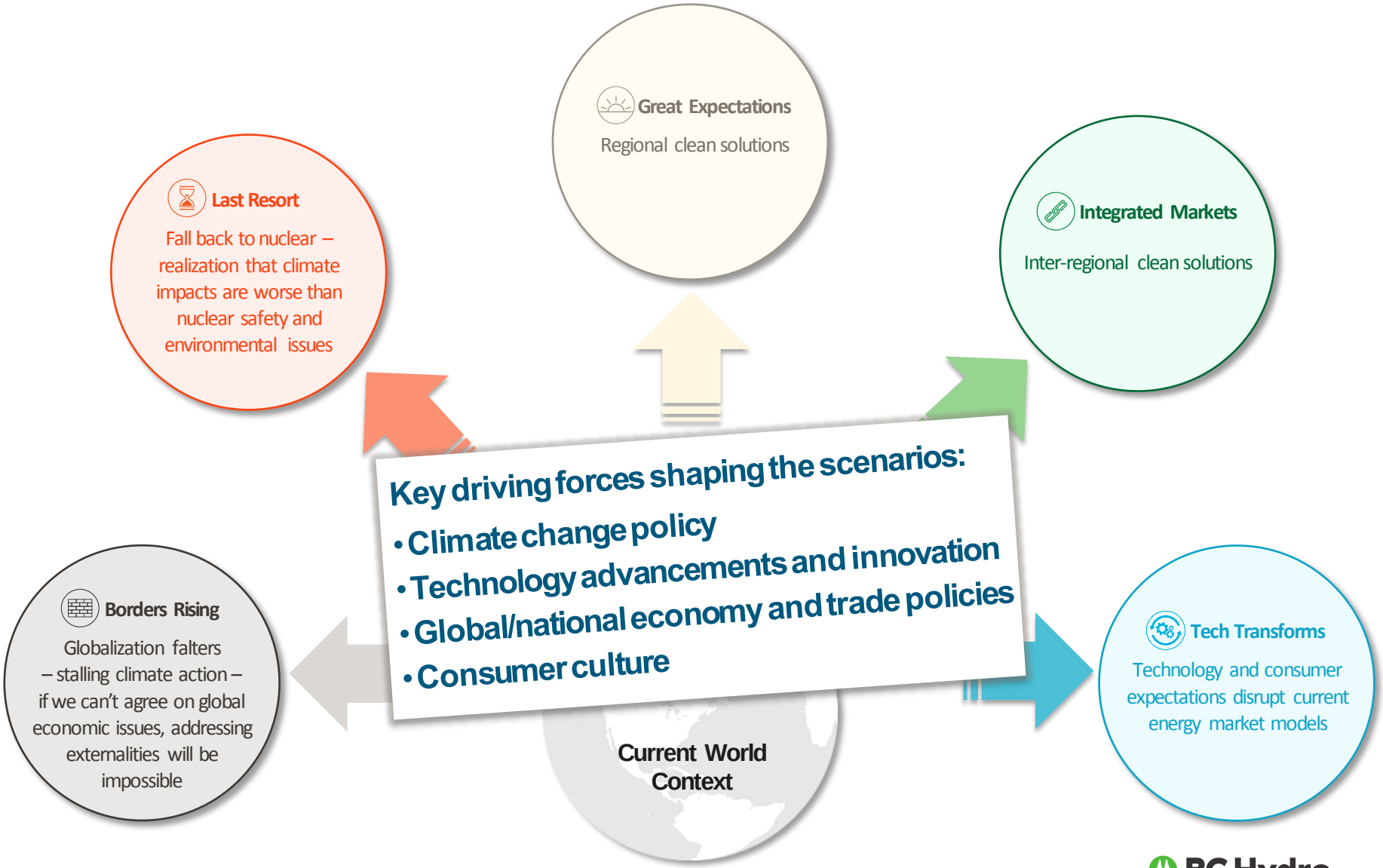
Five Scenarios



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Borders Rising (2050)

Globalization falters – stalling climate action
If we can't agree on global economic issues, addressing externalities will be impossible

How did we get here:

- Benefits of globalization are unequally spread within countries - leads to retrenchment and protectionist attitudes.
- Mistrust of governments and traditional institutions.
- World economic growth slows. Falling trade impacts some countries harder.
- Technological developments are focused on security (including energy security) and less on greater good of society.
- Lack of agreement on how to work together for mutual benefit leads to inaction on global issues/climate change.

Geopolitical Context	Energy Sources / Mix	Energy Use / Consumer Preferences
• Protectionism reigns and conflicts abound across the globe. • Lack of coordination on fighting climate change and most global issues.	• Fossil fuels low cost, plentiful and widely used. • Coal still a big part of the electricity mix and China continues to be world's biggest user of coal. • Growth of renewables falters.	• Transportation sector dominated by gasoline powered personal use vehicles. • Advances in energy efficiency is slow across all major sectors. • Environmental awareness plays secondary role.

Last Resort (2050)

Fall back to nuclear energy
Realization that climate impacts are worse than nuclear safety and environmental issues

How did we get here:

- Severe impacts of climate change are experienced, with an awareness that current approaches with variable renewable resources are not working fast enough.
- The rise of economies outside of North America and Europe make for a competitive world without clear leadership on addressing global issues.
- China, India and other Asian, African nations adopt nuclear energy on a wide scale. It is the last resort to produce non-GHG emitting electricity on a scale required for massive population centers.

Geopolitical Context	Energy Sources / Mix	Energy Use / Consumer Preferences
• Rapid growth in Asia and Africa shifts global economic power. • Variety of climate change adaption measures are implemented across the globe to address impacts such as sea level rise and more frequent storms.	• Nuclear makes a comeback in North America driven by need to stay cost-competitive. Coal with carbon capture adopted in favorable geographies. Minor role for renewables. • Fossil fuels use is diminished. Conventional coal phased out.	• Per capita energy use increases as climate adaption increases energy demand. • Transportation sector is heavily electrified. • Lackluster growth in distributed generation and storage.

Great Expectations (2050)

Regional clean solutions

How did we get here:

- Governments continue to delay addressing climate issues head on through carbon pricing and instead direct solutions through policy and standards.
- Strong and widespread economic growth in a world relatively devoid of conflict allows nations to focus on global issues.
- Increasing globalization, continued major advancements in communications technologies allow societies to appreciate and voice concerns about global issues.
- Nations, local governments, and organizations compete to be branded 'Green' and gain an economic advantage.

Geopolitical Context	Energy Sources / Mix	Energy Use / Consumer Preferences
• High and widespread economic growth. • Nations act autonomously in fighting climate change. A mixed bag of approaches across the world, yet effective.	• Renewables backed up by gas capacity is the default source of electricity in North America. • Coal phased out. Gasoline use is limited to marginal applications.	• Efficiency improvements in the built environment sector are widespread. • Transportation sector is heavily electrified. • Distributed generation growth limited.

Integrated Markets (2050)

Inter-regional clean solutions

How did we get here:

- Governments avoid carbon pricing, yet facing issues in integrating renewables. They are forced to seek cooperation as realization dawns that integration of variable renewable resources is too big of a problem for each jurisdiction to solve single handedly.
- Transportation of renewable energy over large distances (e.g., solar from Africa to Europe) is commonplace.
- Finding economic efficiencies in addressing societal needs is a key theme. Protectionist concepts become outdated.
- The impacts of climate change such as rise in sea level are strongly felt.

Geopolitical Context	Energy Sources / Mix	Energy Use / Consumer Preferences
• Open markets in a world where economic growth is moderate. • Federal governments in both U.S. and Canada play very active role in shaping energy sector through legislation and incentives related to energy efficiency and clean infrastructure development.	• Coal and baseload gas phased out. • Renewable generation clusters emerge (e.g., solar in the southern US / Mexico). The continental grid strengthens with addition of efficient Direct Current links. Storage / regulation capabilities are highly valued.	• Efficiency improvements in the built environment sector are widespread. • Transportation sector is heavily electrified. • Distributed generation growth limited.

Tech Transforms (2050)

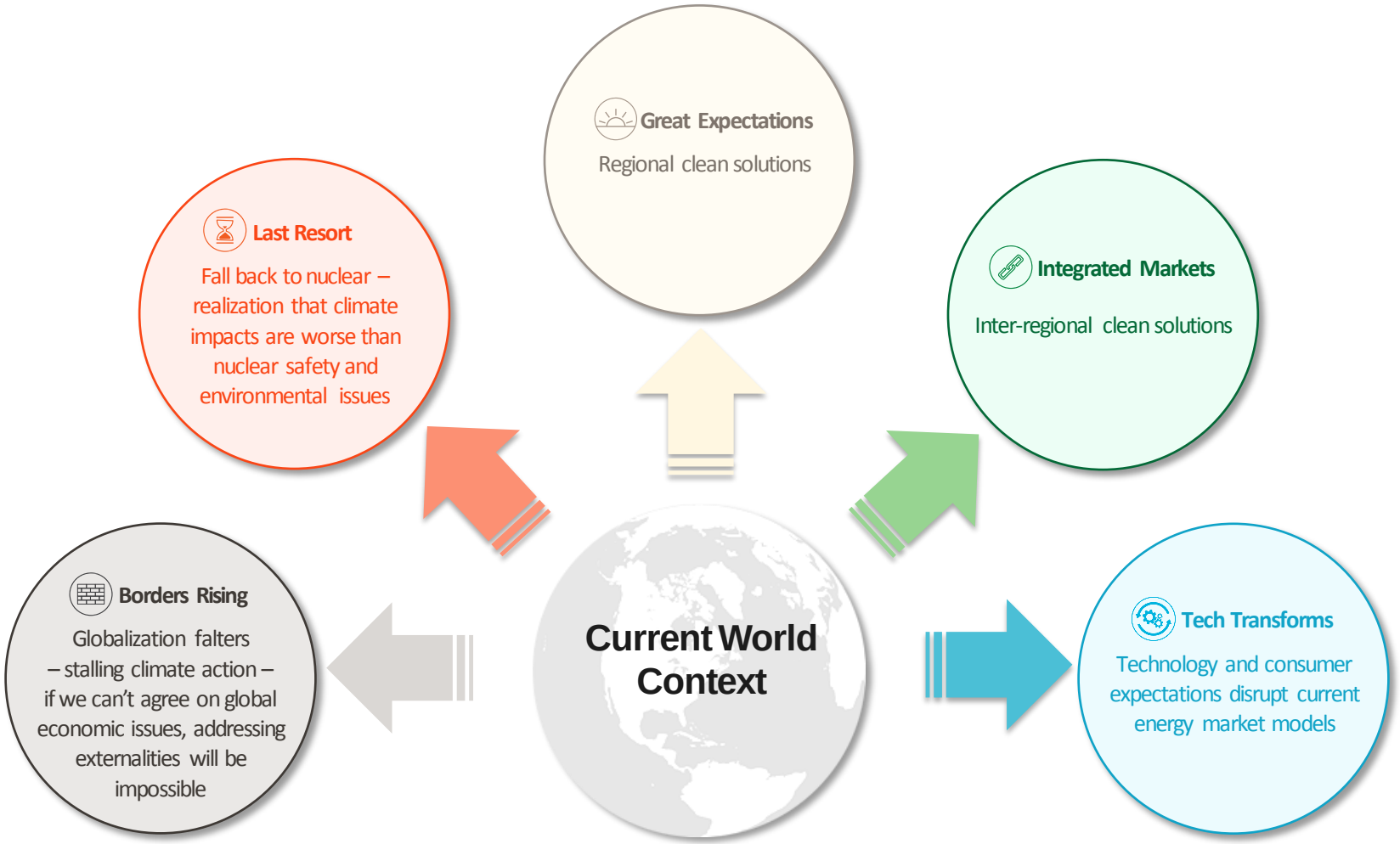
Technology and consumer expectations disrupt current energy market models

How did we get here:

- Carbon pricing and fewer government directives results in technology advancements and innovation across multiple sectors led by private organizations.
- Consumers expectations undergo dramatic changes in a sharing economy facilitated by advanced communication technologies and driven by economic necessity – shared, self-driving, electric cars are the mode of 'personal' transportation.
- Climate policies become less crucial later on as society becomes more efficient and low GHG as a result of technology advancements.

Geopolitical Context	Energy Sources / Mix	Energy Use / Consumer Preferences
• The world is a global village. • Power shifts to global corporations and local governments.	• Distributed generation play a key role in smart, community energy systems. • Battery technology has widespread adoption reducing need for 24 hour grid service.	• Energy efficiency is paramount with Artificial Intelligence playing a key role in managing energy usage.

Scenario Summary



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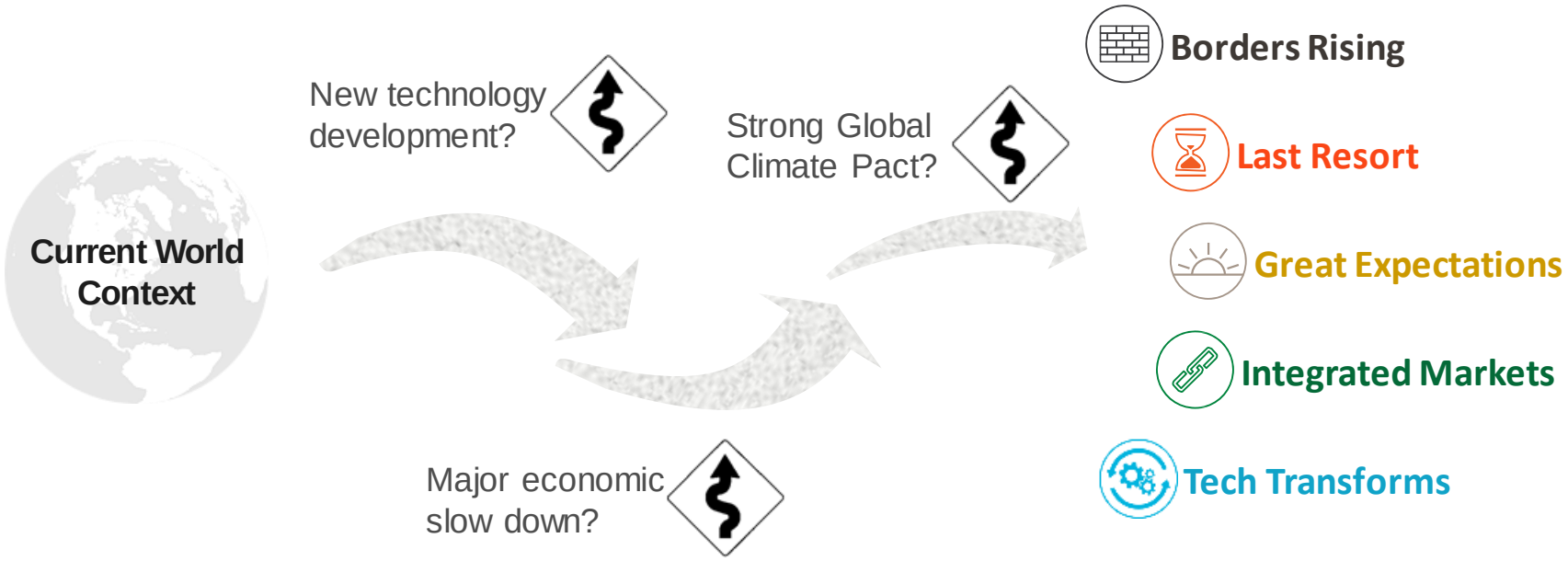
The Path to the Future

Will not be a straight line nor be obvious

- Scenarios enable us to incorporate uncertainty into the planning process:
- Force us to consider a range of end states (future world) and transition pathways
- Identify road signs so we know when to adjust course of actions



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SCENARIO DESCRIPTIONS

Do these worlds resonate?

Are there any important aspects that we have missed?

Are there any insights from your industries / knowledge areas?

Any road signs you think would be particularly significant?

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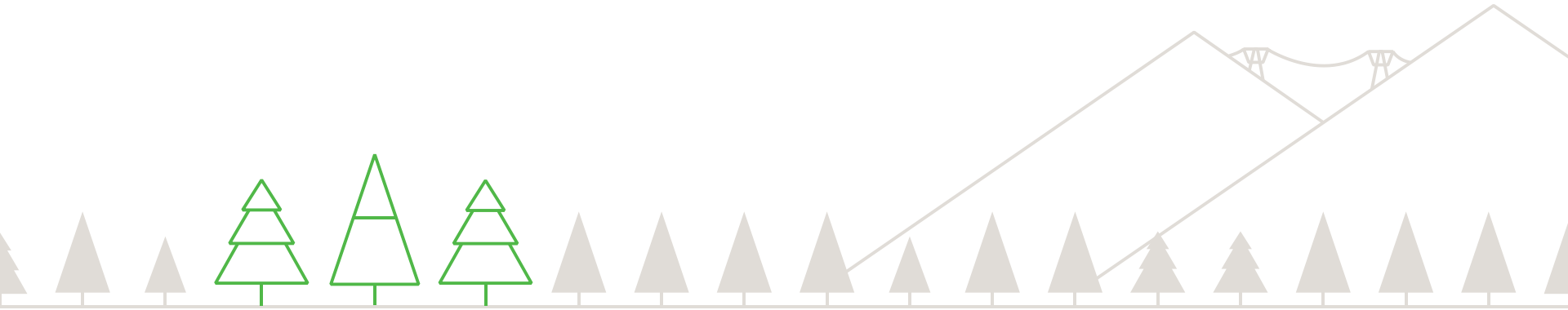
IRP Key Questions & Work Plan Highlights



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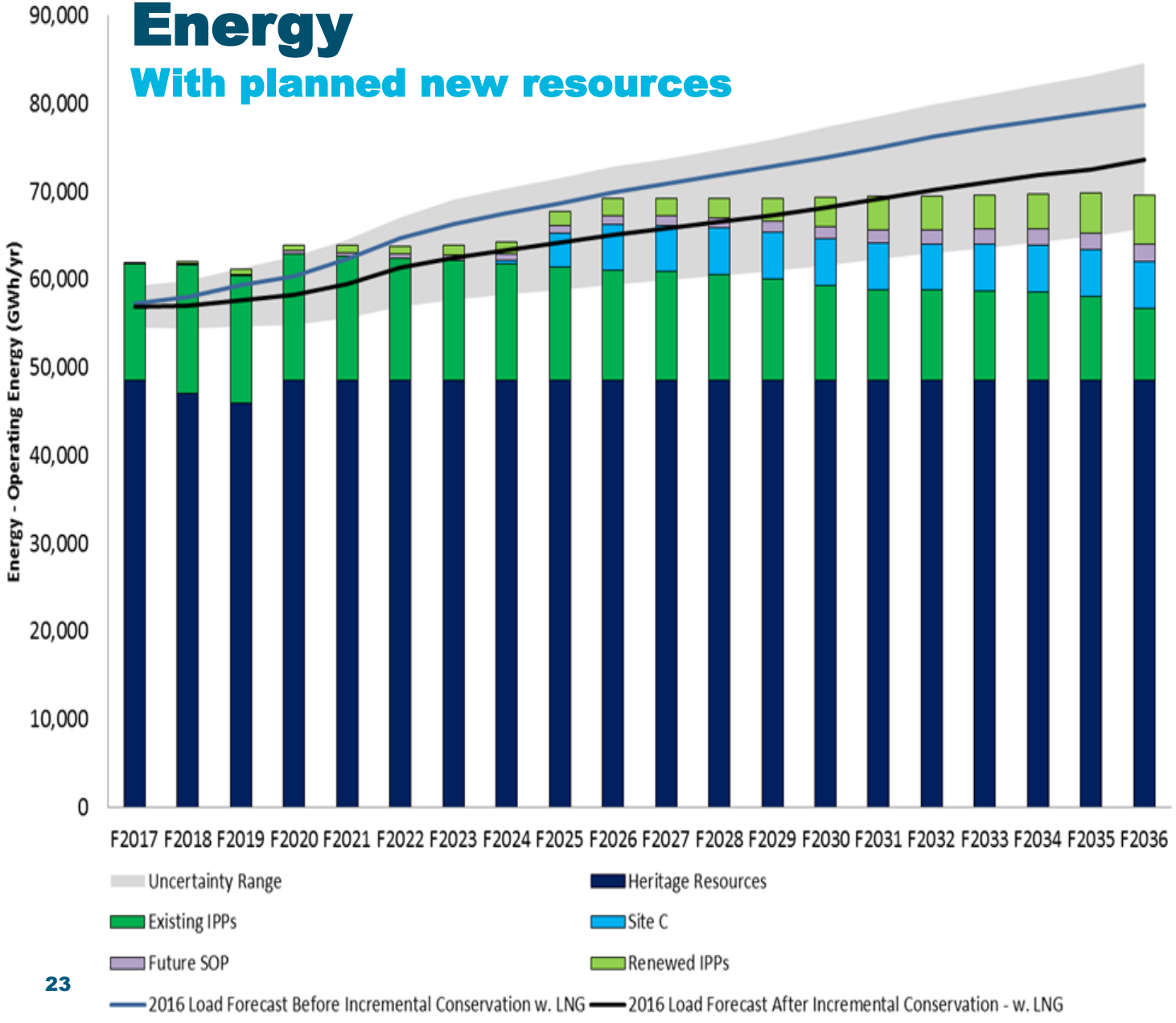
Energy

With planned new resources



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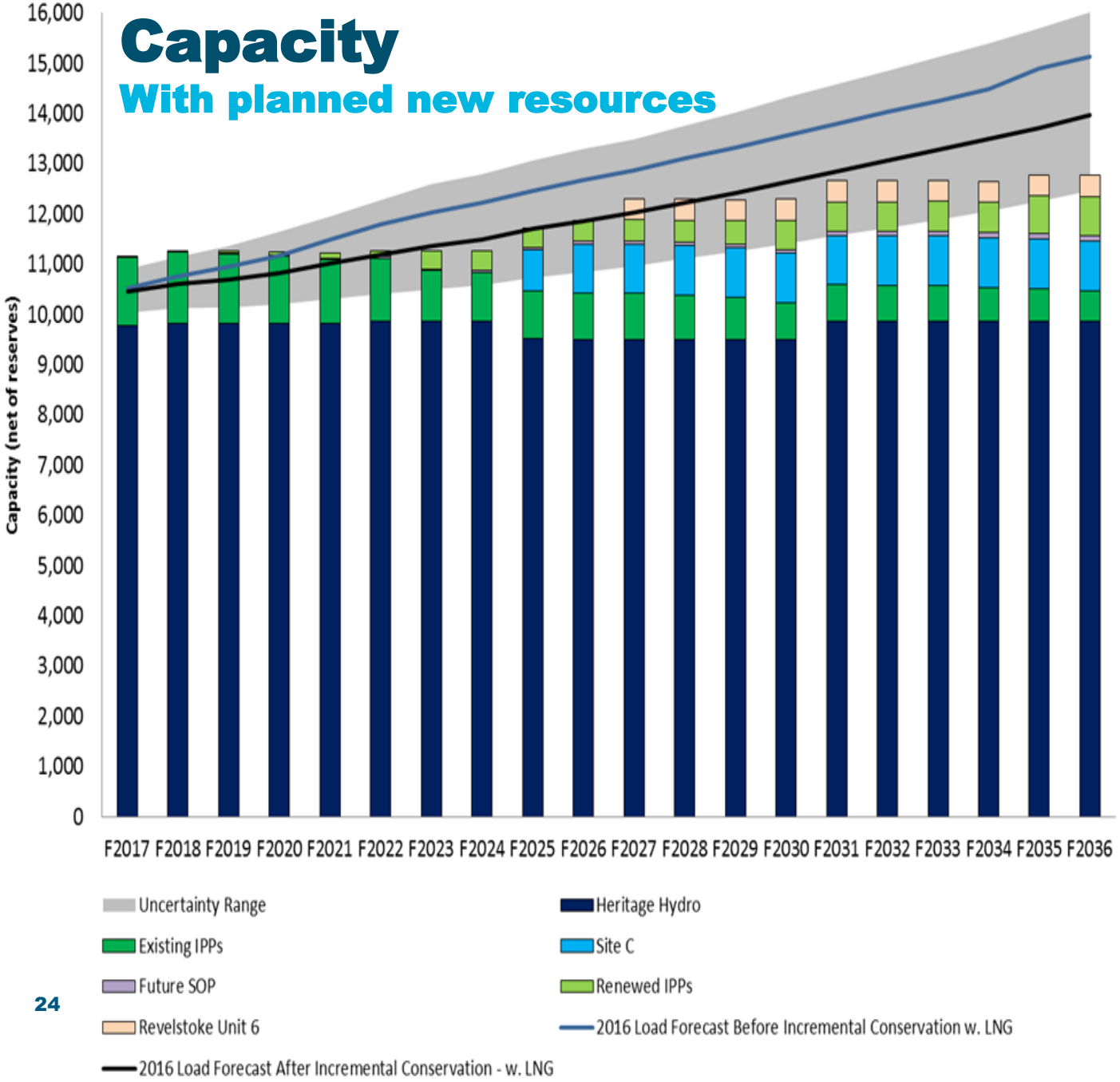
Capacity

With planned new resources



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2018 IRP – Key Questions

Q1. What's the demand-side management target beyond 2020?

Q2. What's the IPP acquisition strategy?

e.g., next Clean Power Call – when? Capacity Call? Anything new on EPA Renewal & Standing Offer Program?

Q3. What are key capital resource additions?

e.g., FID for Rev 6? If and when do we need next major transmission line, e.g., Interior to Lower Mainland?

Q4. What's our role in supporting climate actions?

e.g., how much electrification (fuel switching) do we drive?

Q5. What's our role as a utility in a world with changing consumer culture and technology advances etc.?

e.g., inform our strategies on grid modernization, rate design (such as net metering tariff), and customer service.

IRP Key Considerations

Uncertainties

Climate Policies | Technological Advancements | Global Economics | Consumer Culture

Outside of B.C.

Current Outlook
e.g., Pan Canadian Framework
Policies in neighboring jurisdictions

Scenarios
Narratives and modelling

GLOBAL PARAMETERS | MARKET CONDITIONS / PRICES | ELECTRICITY INDUSTRY IN NORTH AMERICA

B.C. Policy Context

e.g., Clean Energy Act, Climate Leadership Plan, Municipal targets

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- Electrification
- Export Opportunities
- Net Metering and DG uptake
- Climate Change Effects

- Climate Change Effects

- EPA Renewal
- Resource Options Inventory:
  - Supply
  - Conservation
  - Transmission

- Customer preferences

Demand (Q.4)	Existing & Committed Supply	Future Resources (Q.1-3)	Other Aspects? (Q.5)

DEVELOP THE IRP

Look for strategies that position us for success regardless of which future scenario unfolds, and minimize regrets

Next step on Scenarios (2050) Implications – early thoughts:

Great Expectations

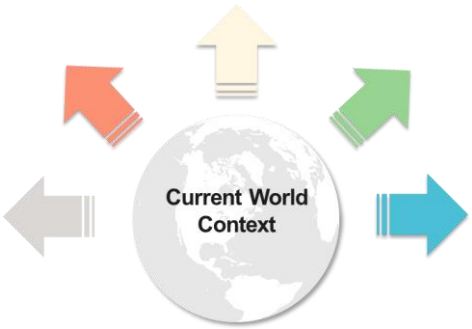
- Significant load growth across the continent due to electrification
- Renewable energy sector flourishes

Last Resort

- Cost of electricity in North America plateaus or drops as nuclear provides a ceiling

Integrated Markets

- Long-term, long-distance electricity trade deals become commonplace



Borders Rising

- Trade barriers result in industries faltering in some areas while flourishing in other regions
- Cheap coal and gas dominate the electricity sector and premiums for clean energy diminish

Tech Transforms

- A numbers of customers turn to self-generation
- Customers look for more choice in electricity service providers / products

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Climate Change

Two essential aspects of the climate change dialogue

Mitigation

- An anthropogenic (human) intervention to reduce the sources or enhance the sinks of greenhouse gases

Adaptation

- Adjustment in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

** As defined by Intergovernmental Panel on Climate Change (IPCC)*

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Mitigation – Climate Policies

Our role driven by government policies, and legislative and reporting requirements

Our primary contribution includes acquiring DSM and clean supply side resources to meet demand, supporting electrification etc.

Federal

- Pan Canadian Framework
- Federal infrastructure funds – PRES, NRCAN study

Provincial

- 100% Clean – new acquisitions going forward unless reliability/cost concern
- 10–year emissions reduction and adaptation plans
- Low Carbon Electrification – Section 18

Municipal

- Navius study with City of Vancouver

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Adaptation

Our role driven by corporate due diligence and requirements for adaptation plan per the Climate Leadership Plan

Climate change impacts and implications for IRP:

- Changes to water supply and average temperatures can impact **resource adequacy**
  e.g., generation, load
- Changes to weather patterns (severity) can impact infrastructure **resiliency**
  e.g., system reliability
- Increase in competition for water use
  e.g., drinking water, fishery need

Ongoing collaboration with Pacific Climate Impacts Consortium (PCIC) on climate/weather modelling

Previous studies show by 2050:

- Modest increase in annual water supply, and significant change in runoff timing
- 1.4 to 3.7°C increase in mean temperature and 0 to 18% increase in annual precipitation

We will continue to work with PCIC to understand the impact of the updated Intergovernmental Panel on Climate Change (IPCC) emission/climate scenarios, and will advance the understanding of impacts on our system so to guide our adaptation efforts

Resource Options Inventory

- **Characterization of resources in B.C.**
  e.g., cost, GWh, MW, location etc.
- **Results of the latest update have been posted at www.bchydro.com/supplyoptions**
  - Biomass
  - Biogas
  - MSW
  - Run-of-River
  - On-Shore
  - Off-Shore
  - Solar (utility)
  - Wave
  - Tidal
  - Geothermal
  - Pumped Storage
  - Gas CCGTs and SCGTs
  - Resource Smart (e.g., Rev 6)
  - Transmission

Considering focusing efforts next on:

- Utility and Rooftop Solar
- Run-of-River Storage Hydro
- Biomass Fiber
- Batteries, EV
- DSM Energy Options
- DSM Capacity Options

- **Continue to monitor technology/market development**

Distributed Solar Generation in B.C.

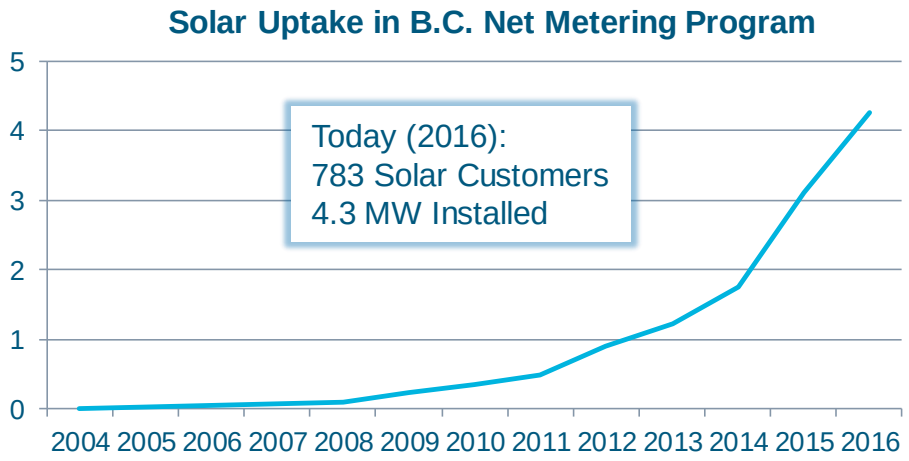
Small at this time but growing

We will continue to monitor, and will study and consider scenarios

- In the U.S., significant customer adoption and annual growth of new distributed generation solar installation over last decade
  - 2.2 GW of new residential installations in 2015, 2.7 GW expected in 2016
  - Attracting customers to displace electricity purchase from the grid

- In B.C., adoption of residential solar in the Net Metering Program has been small but is growing
  - When will it take off? Slower relative to the US: B.C. has a poorer solar resource, lack of financial incentives and higher cost of system installation (nascent market)
  - Projects in the Net Metering Program are mostly solar PV projects

Customer adoption?
Rate design?
Grid impacts?
Emerging business models?



Demand-Side Management

Target beyond 2020

- Minister expects 'BC Hydro to consult on a new long-term conservation target, beyond 2020, through the 2018 IRP process'
- Opportunity for a more stable and meaningful metric, especially given broader mandate

Conservation Potential Review (CPR) is underway and will inform 2018 IRP

- A study that estimates the conservation potential of electricity and natural gas consumption over a period of 20 years
- Joint effort between BC Utilities including BC Hydro, FortisBC Electric, FortisBC Gas, and Pacific Northern Gas
- CPR TAC provided comments on draft technical and economic results; BC Utilities will review comments and then finalize the report

Future DSM options

- Will be informed by CPR
- Capacity focused DSM will also be informed by pilots (load curtailment and DR pilots)
- Engagement with IRP TAC and Energy Conservation & Efficiency Committee – approach to be determined
- Will discuss assessing uncertainties and flexibility

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2018 IRP – Timeline & Next Steps

2017 | **2018**

Scope

March to April
Developing work plan and engagement plan

Analysis

January to April

Studies & Inputs

March to December
Scenario narratives and modelling parameters
Risk framework
Resource options inventory and DSM options
Market price
Load forecast
Climate change impacts etc.

Draft/Revise Plan

April to November

*

November
Submit the plan to Gov

Engage & Consult

March 8th
TAC meeting

Fall 2017?
Next TAC meeting

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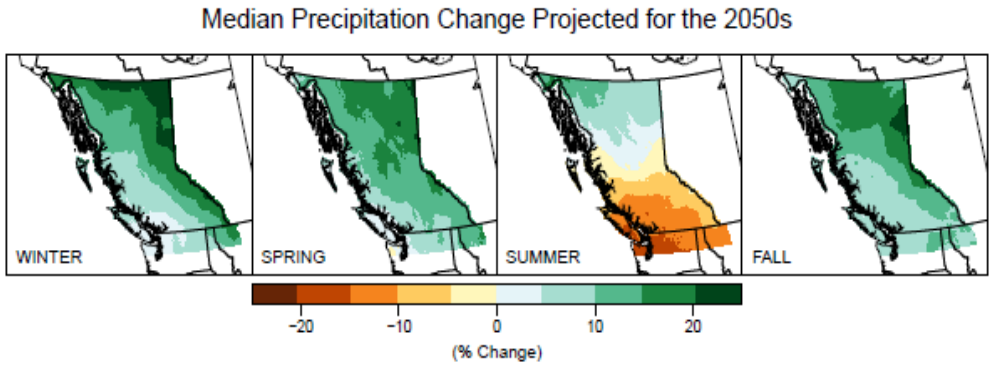
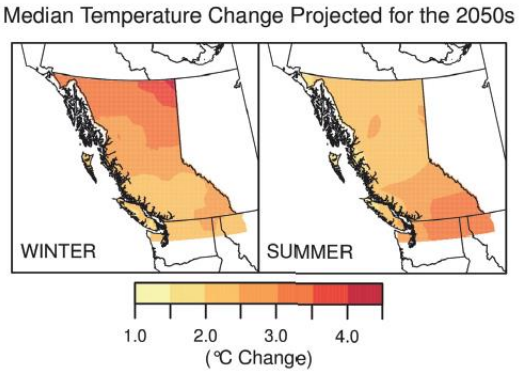
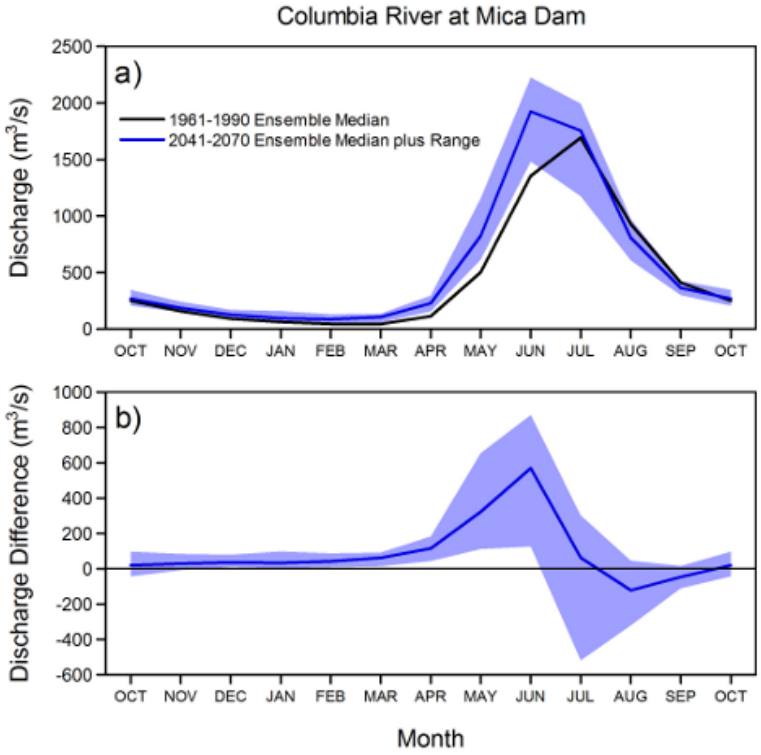
Hydrologic Impacts - Future





By 2050:

- 1.4 – 3.7°C increase in mean temperature
- 0 – 18% increase in annual precipitation
- Modest increase in annual water supply
- Significant change in timing of runoff



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