

FortisBC Inc. Resource Planning Advisory Group Workshop

November 26, 2019



Agenda

8:30 am – 9:00 am	Registration & Breakfast	
9:00 am – 9:20 am	Introductions, FBC Overview, RPAG	Mike Hopkins
9:20 am – 9:40 am	Resource Planning Process, BCUC Decision, Action Items	Mike Hopkins
9:40 am – 10:10 am	Resource Planning Environment	Dan Egolf
10:10 am – 10:40 am	Customer Profile and Load Forecasting	David Bailey
10:40 am – 10:50 am	Break	
10:50 am – 12:20 pm	Load Drivers and Scenarios	Peter Steele - Mosey
12:20 pm – 1:00 pm	Lunch	
1:00 pm – 1:30 pm	Demand-Side Management	Steven Groves
1:30 pm – 2:00 pm	FBC Resources and Power Markets	Shannon Price
2:00 pm – 2:10 pm	Break	
2:10 pm – 2:40 pm	LRB, Resource Options, Portfolio Analysis	Mike Hopkins
2:40 pm – 3:00 pm	Wrap-Up and Next Steps	Mike Hopkins

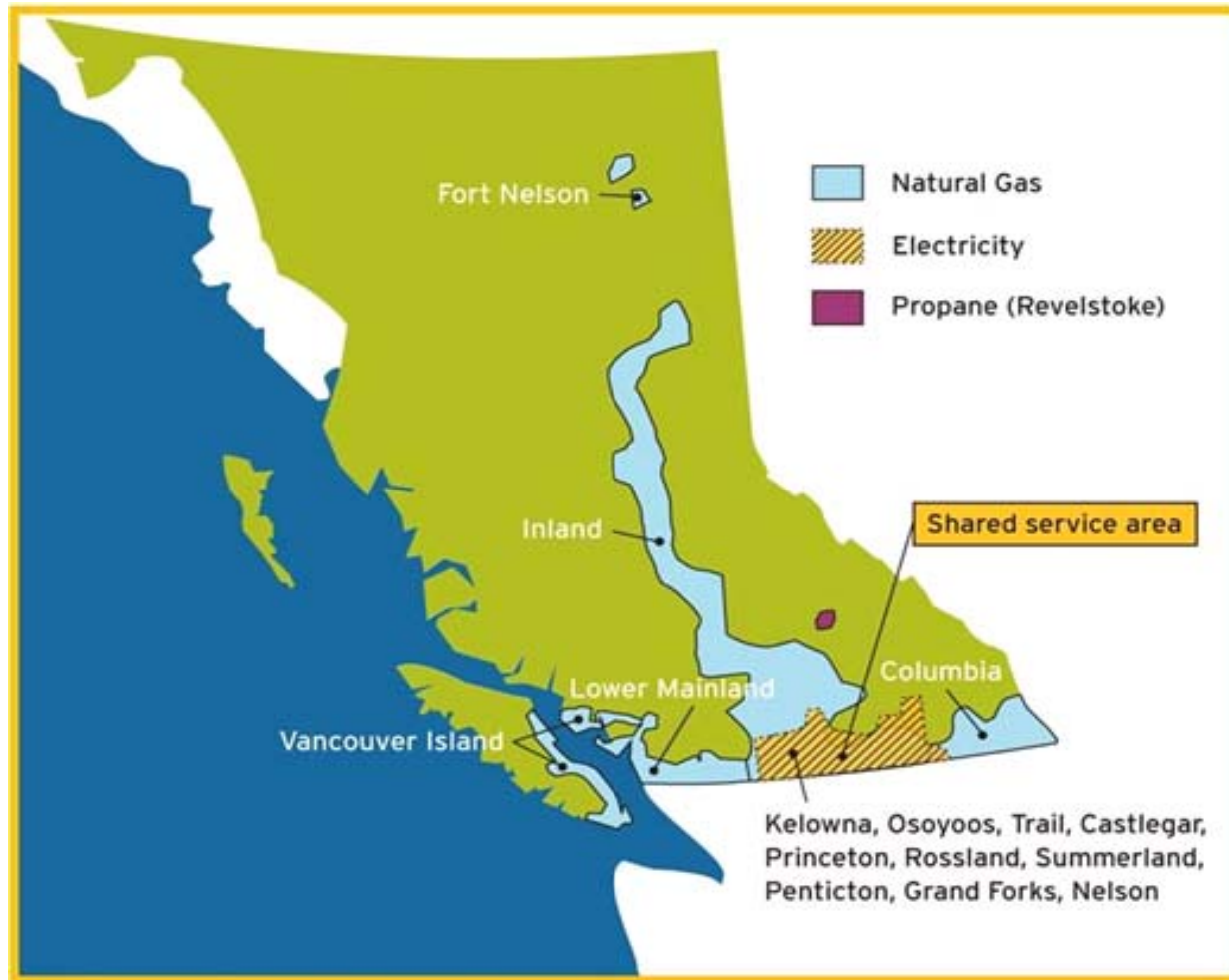
Welcome and Introductions

RPAG Members

Affiliation	Member	Position
B.C. Ministry of Energy & Mines - Electricity and Alternate Energy Division	Warren Walsh	Strategic Energy Manager
B.C. Municipal Electric Utilities (BCMEU)	Alex Love	General Manager, Nelson Hydro
B.C. Public Interest Advocacy Centre (BCPIAC)	Leigha Worth	Executive Director & General Counsel
B.C. Sustainable Energy Association (BCSEA)	Tom Hackney	Policy Analyst
B.C. Utilities Commission (BCUC)	Nicola Simon	Executive Director, Facilities and Planning
BC Hydro	Kathy Lee	Resource Planning Specialist
Clean Energy Association of B.C.	Martin Mullany	Executive Director
Commercial Energy Consumers Association of B.C. (CEC)	David Craig	Executive Director
Friends of Kootenay Lake Stewardship Society	Camille Leblanc	Assistant Environmental Manager
Industrial Customers Group (ICG)	Robert Hobbs	Council for the ICG
Irrigation Rate Payers Group	Brian Mennell	Chairman, Fairview Heights Irrigation District
Pembina Institute	Tom-Pierre Frappé-Sénéclauze	Director, Buildings and Urban Solutions
MoveUp	Jim Quail	Legal Director
FortisBC	Mike Hopkins	Senior Manager, Price Risk & Resource Planning
FortisBC	Dan Egolf	Senior Manager, Power Supply & Planning
FortisBC	Steven Groves	Engineer, C&EM
FortisBC	David Bailey	Customer Energy & Forecasting Manager
FortisBC	Joyce Martin	Manager, Regulatory Affairs
FortisBC	Ryan Steele	Power Supply Planning Specialist
FortisBC	Ron Zeilstra	Resource Development Manager
FortisBC	Robert Schuster	Integrated Resource Planning Manager

FortisBC Overview

FortisBC

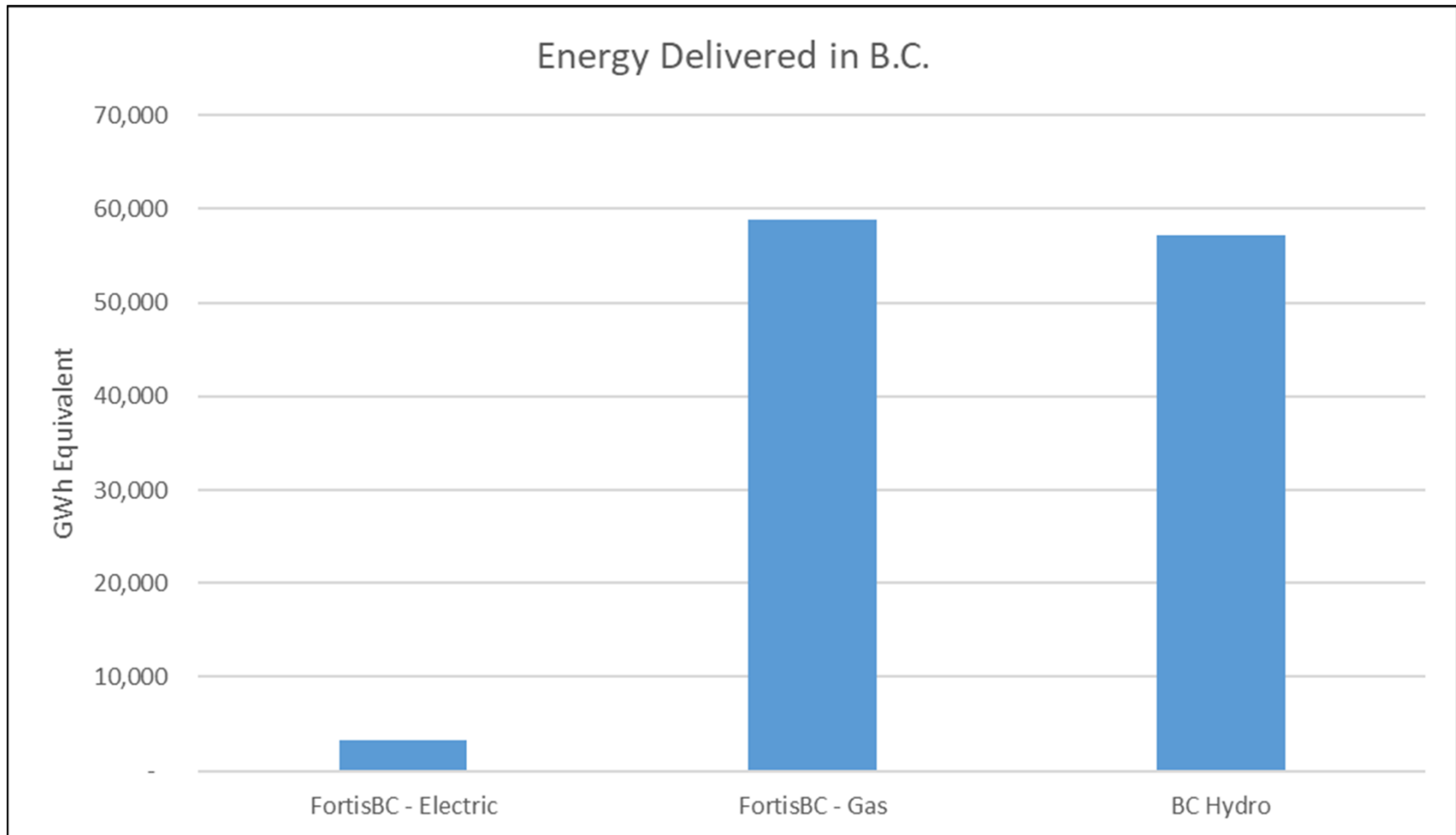


- Serving 1.2 million customers across 135 communities
- Approximately 177,000 electricity customers

FortisBC Shared Service Territory



Energy Delivered in B.C.



Four pillars of our Clean Growth Pathway



Energy efficiency



Renewable
Natural Gas



Global LNG



Zero and
low carbon
transportation

FortisBC Emissions Reduction Target

What is 30BY30?

It is our target to reduce our customers' GHG emissions by **30%** overall by the year **2030**



Questions?

Resource Planning Advisory Group (RPAG)

RPAG Purpose and Objective

Purpose:

- Inform, update stakeholders on our resource planning
- Get input and feedback from stakeholders

Objective:

- Help develop a more informed and robust resource plan

RPAG Roles and Responsibilities

FBC:

- Facilitate meetings and lead discussions
- Provide agendas, topics and background material
- Record and circulate meeting notes
- Consider suggestions and stakeholder input

Stakeholders:

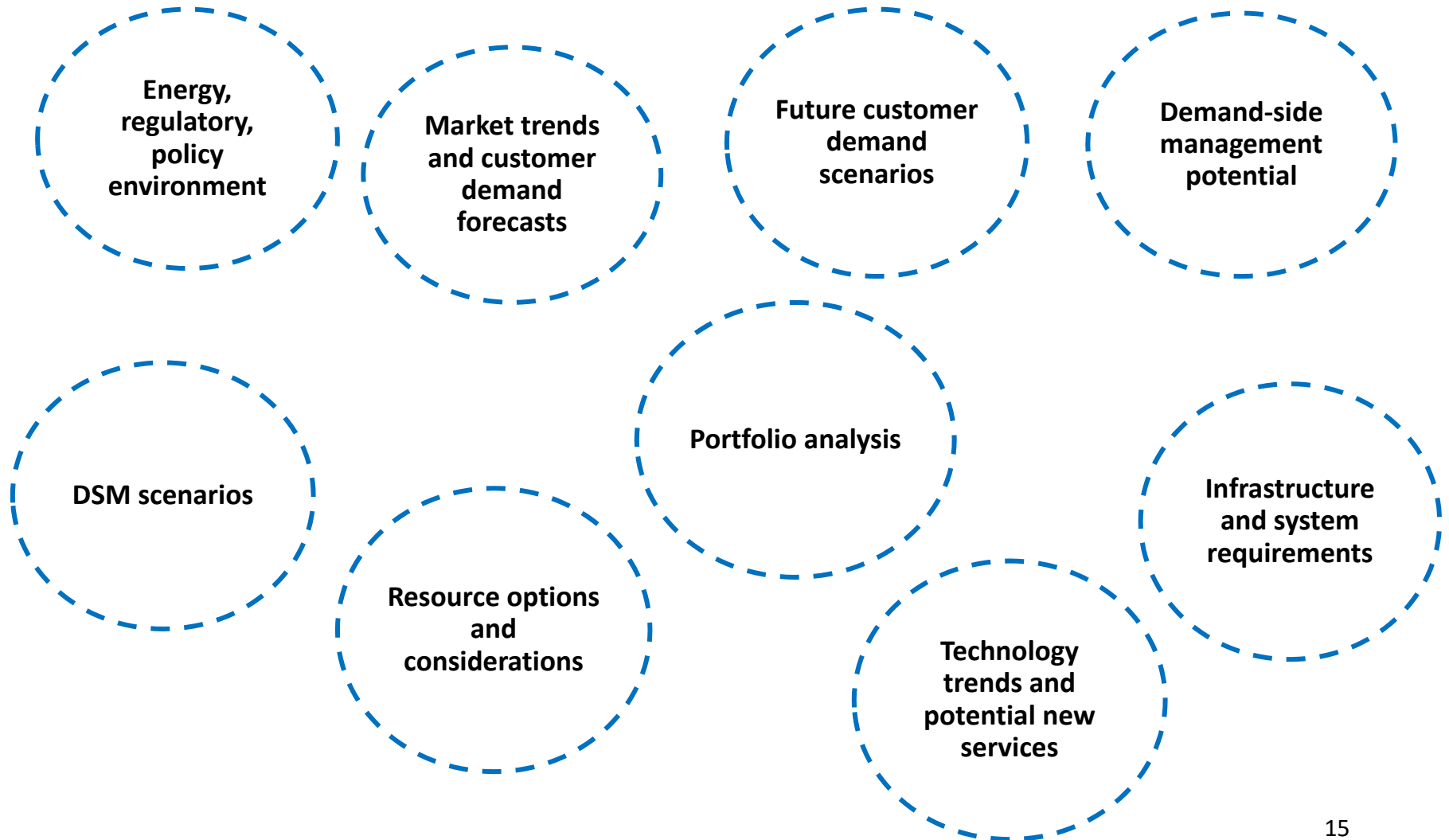
- Provide feedback and suggestions
- Raise issues and suggest solutions
- Bring forth ideas beneficial to all
- Keep topics within the scope

BCUC Staff:

- Participate impartially
- Gain understanding of issues to aid BCUC in reviewing LTERP
- Share expertise in regulatory requirements and precedents

RPAG Scope

Understand, review and comment on aspects of the LTERP



Terms of Reference (ToR)



Defines the goals and expectations for RPAG

Questions?

Resource Planning, BCUC Decision, Action Items

Mike Hopkins

Senior Manager, Price Risk & Resource Planning

LTERP Objectives

- Ensure cost-effective, secure and reliable power for customers
- Provide cost-effective demand-side management and cleaner customer solutions
- Consistency with provincial energy objectives (e.g. applicable *Clean Energy Act* objectives, CleanBC plan)

Utilities Commission Act (UCA)

Utility requirements - Section 44.1(2):

- Demand forecast before and after DSM
- Identify resources required to meet demand
- Explain why any required demand not met with DSM

BCUC Considerations - Section 44.1(8):

- BC energy objectives and *CEA*
- Adequate, cost-effective DSM
- Interests of persons who receive or may receive service

Key BC *Clean Energy Act* Objectives

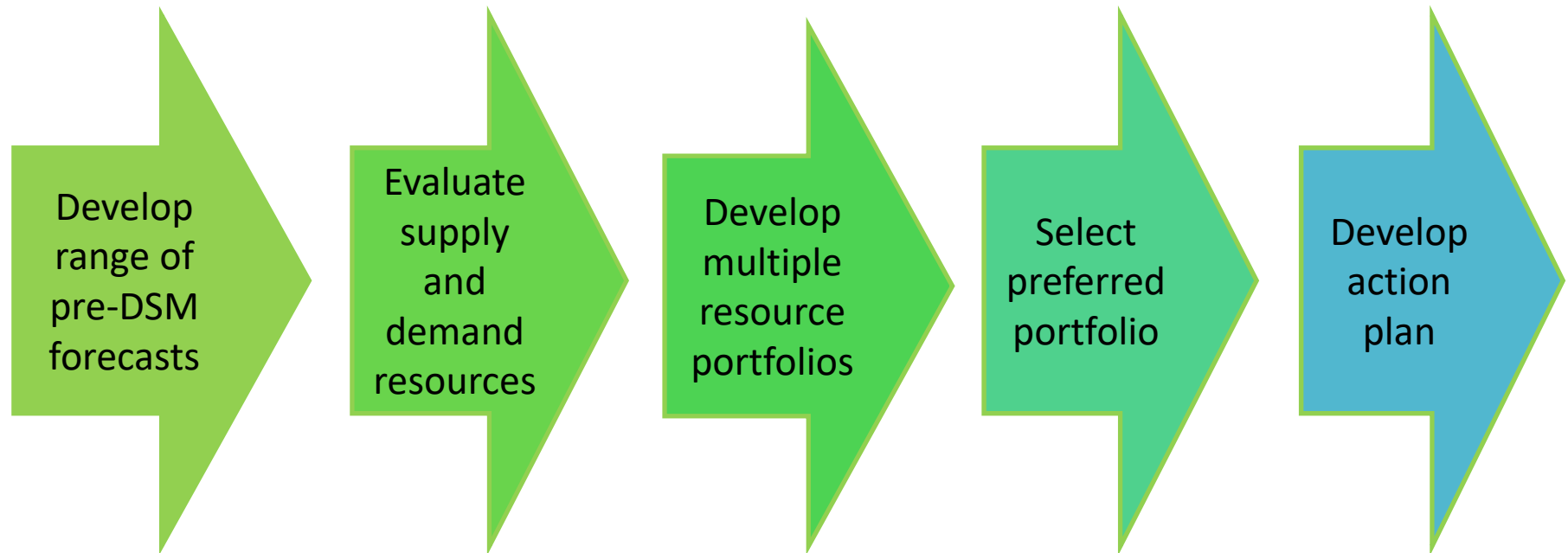
- BC Hydro must achieve electricity self-sufficiency
- BC Hydro to generate at least 93% of BC electricity from clean or renewable resources*

Other electric utilities must consider the objectives above

- BC Hydro to reduce expected increase in demand by at least 66% through demand-side management by 2020
- Foster First Nations and communities economic development
- Reduce GHG emissions in BC

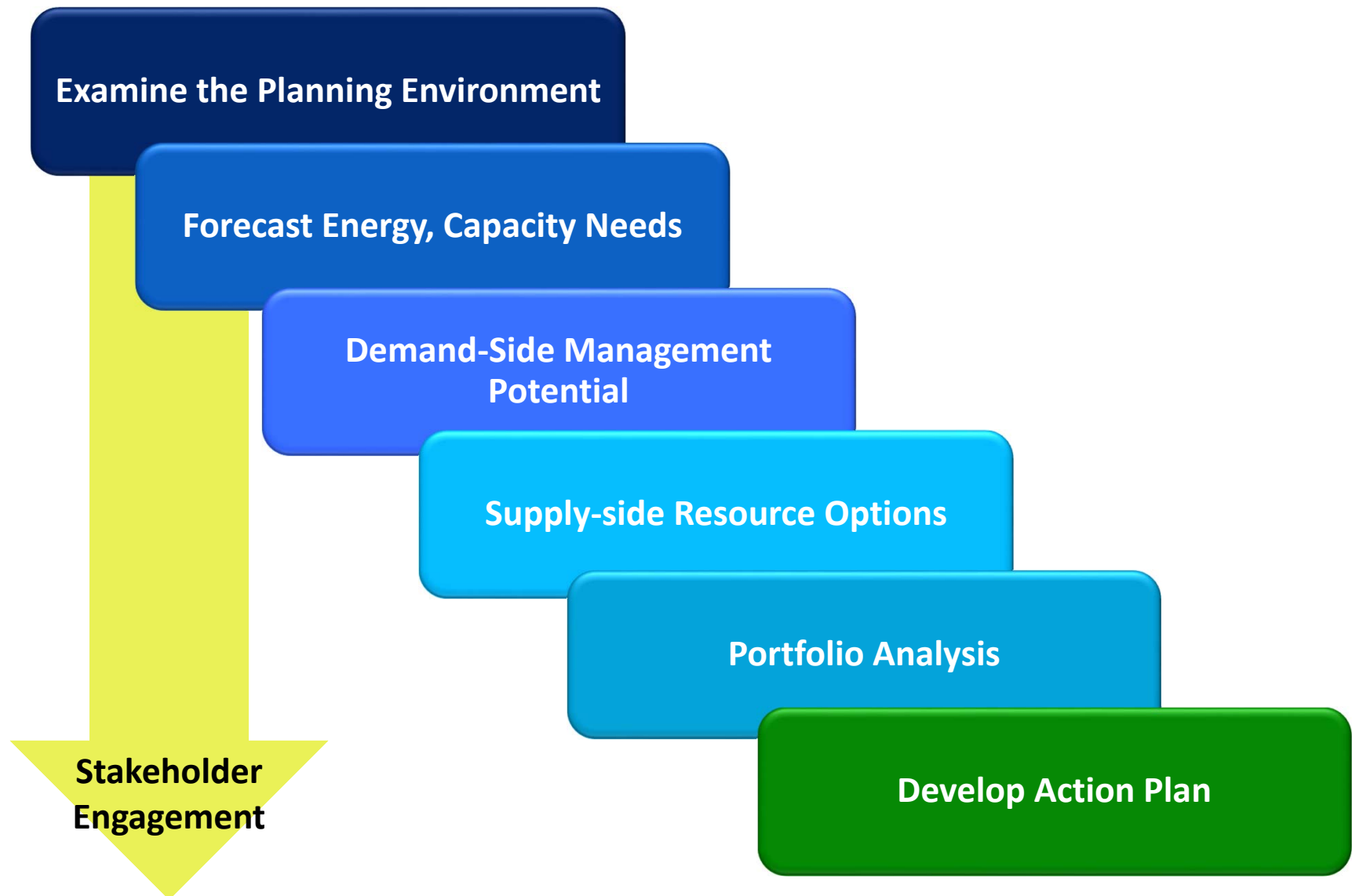
**Includes biomass, biogas, geothermal heat, hydro, solar, ocean, wind or any other prescribed resource*

BCUC *Resource Planning Guidelines*



- Stakeholder and BCUC input
- Consider government policy

Long-Term Resource Planning Process



2016 LTERP – BCUC Decision

BCUC Decision re 2016 LTERP

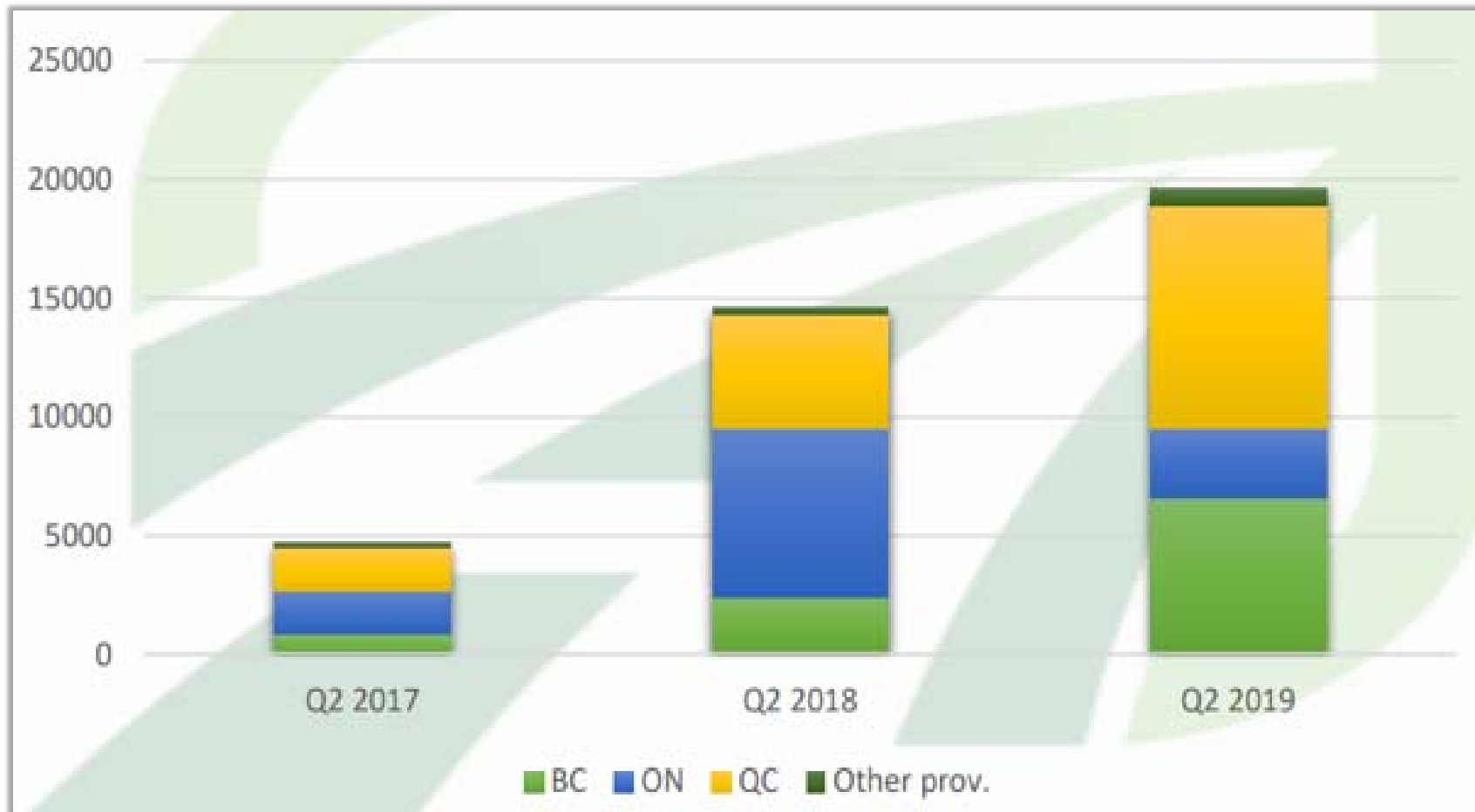
- FBC's overarching objectives in public interest
- Accepted load forecast and LT DSM Plan
- Accepted LTERP up to 2024 - rejected beyond 2024
 - FBC electricity self-sufficiency not in public interest
- More transparent and balanced portfolio rating framework
- Develop 'richer analysis' of DSM alternatives for first 5 years
- Exclude DSM from LRMC calculation
- Use average, not marginal, cost to compare DSM portfolios
- Submit next LTERP and LT DSM Plan by December 1, 2021

2016 LTERP – Action Plan

2016 LTERP Action Plan

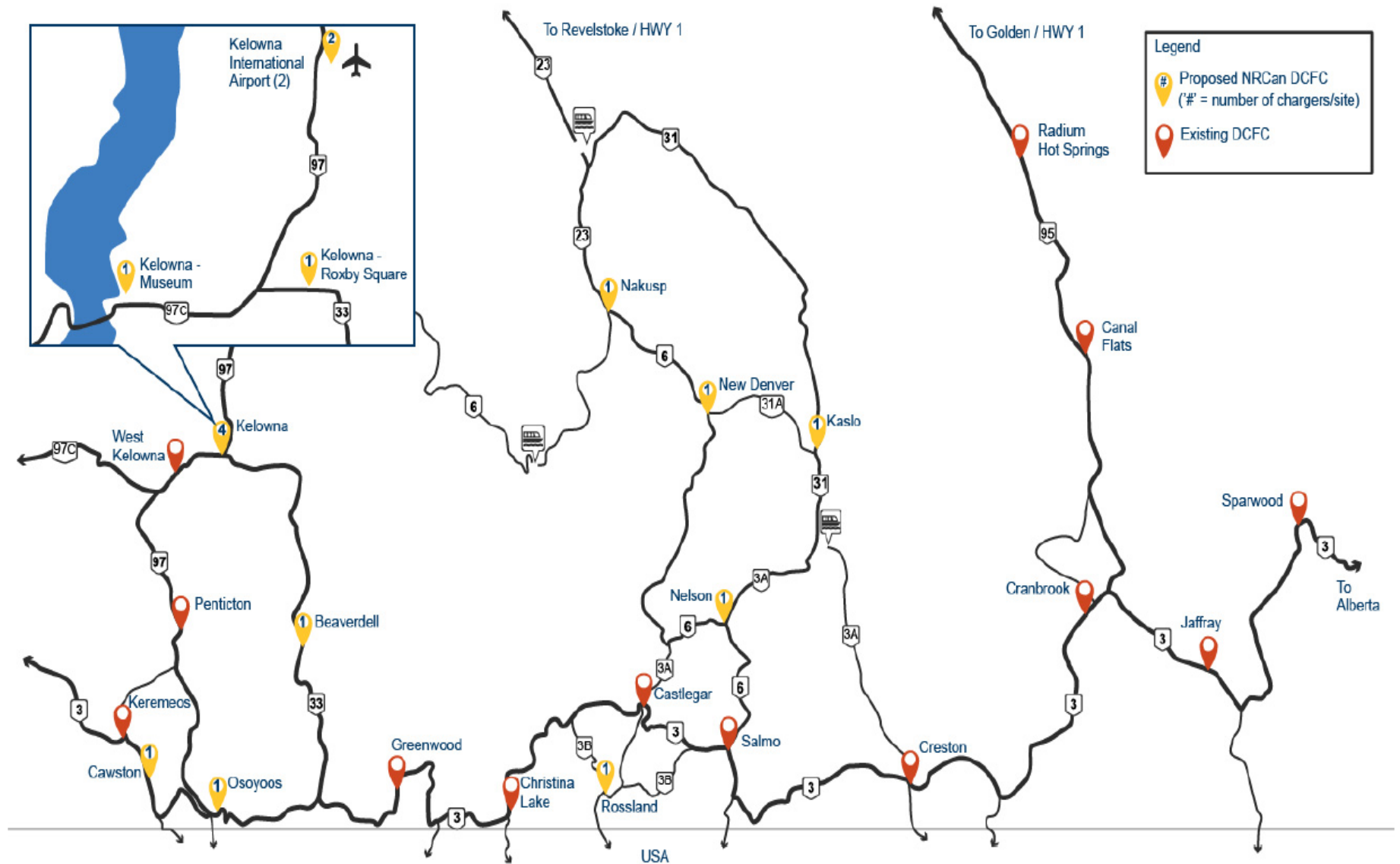
1. Monitor planning environment
2. Monitor potential load drivers
3. Assess requirements/timing for new resources
4. Optimizing PPA and market purchases
5. Complete final phase of CPR
6. Prepare submission of next LTERP and LT DSM Plan

EV Sales Growth by Province



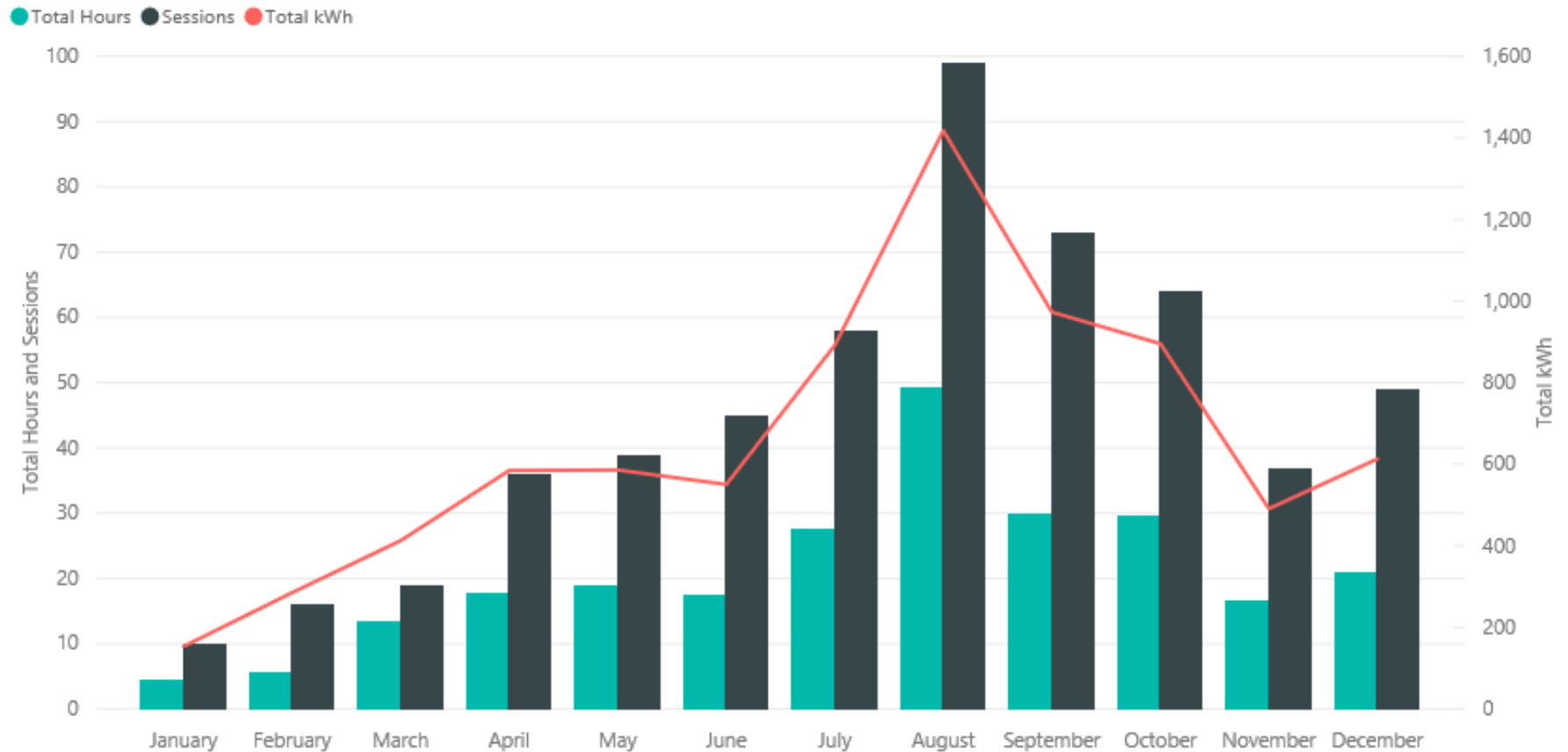
- BC ZEV current estimate ~ 26,000
- BC ZEV target: 500,000 by 2030

Accelerating the Electrification of Transportation

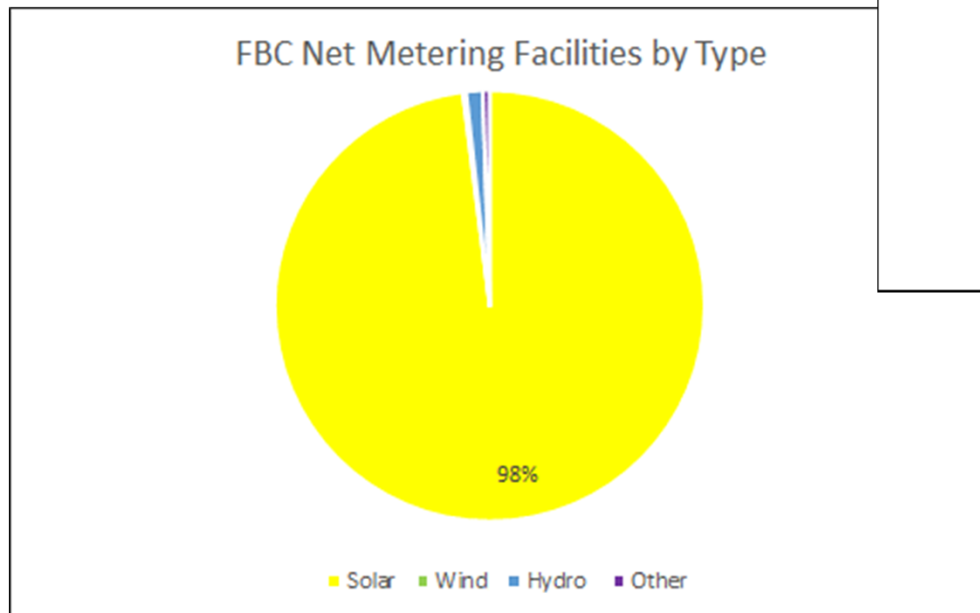
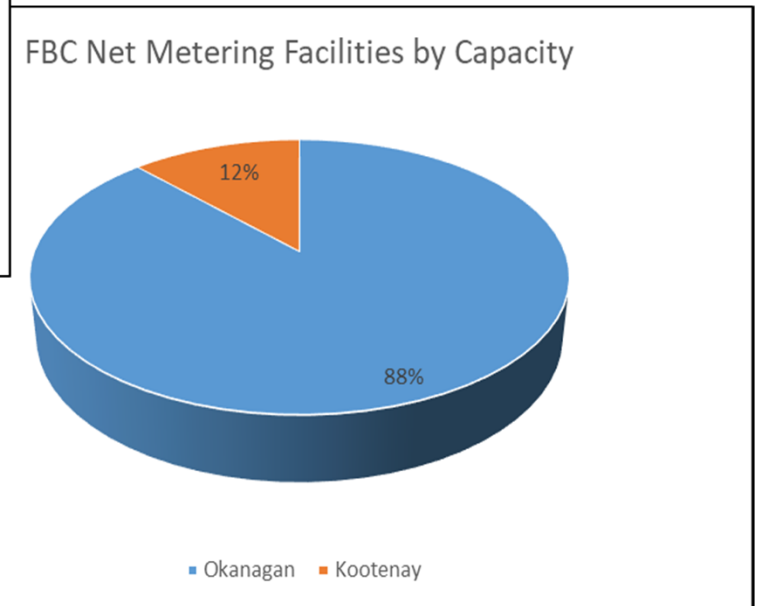
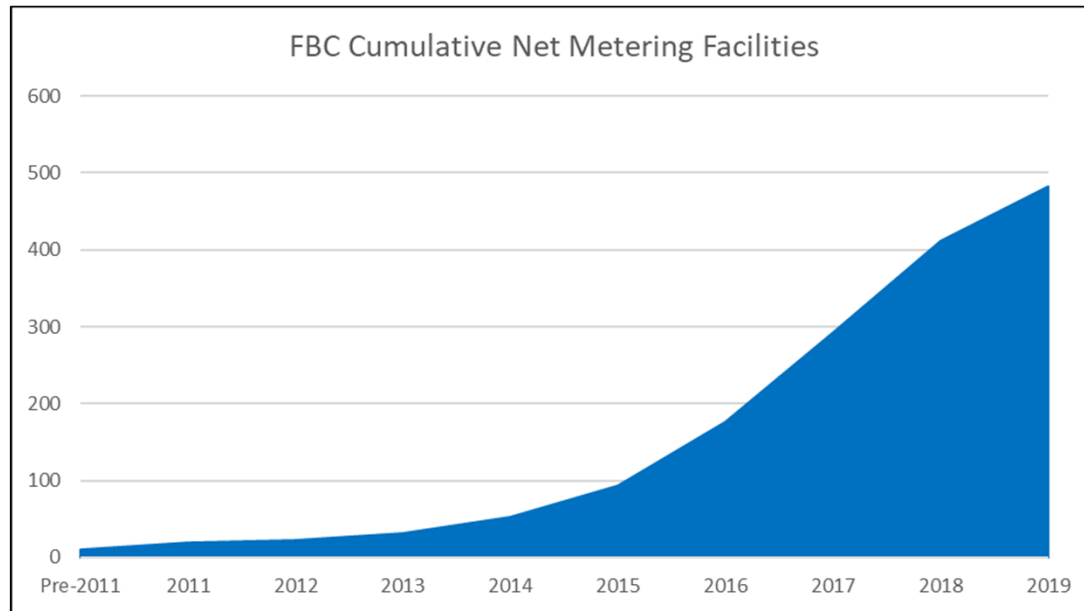


FBC Charging Station Usage

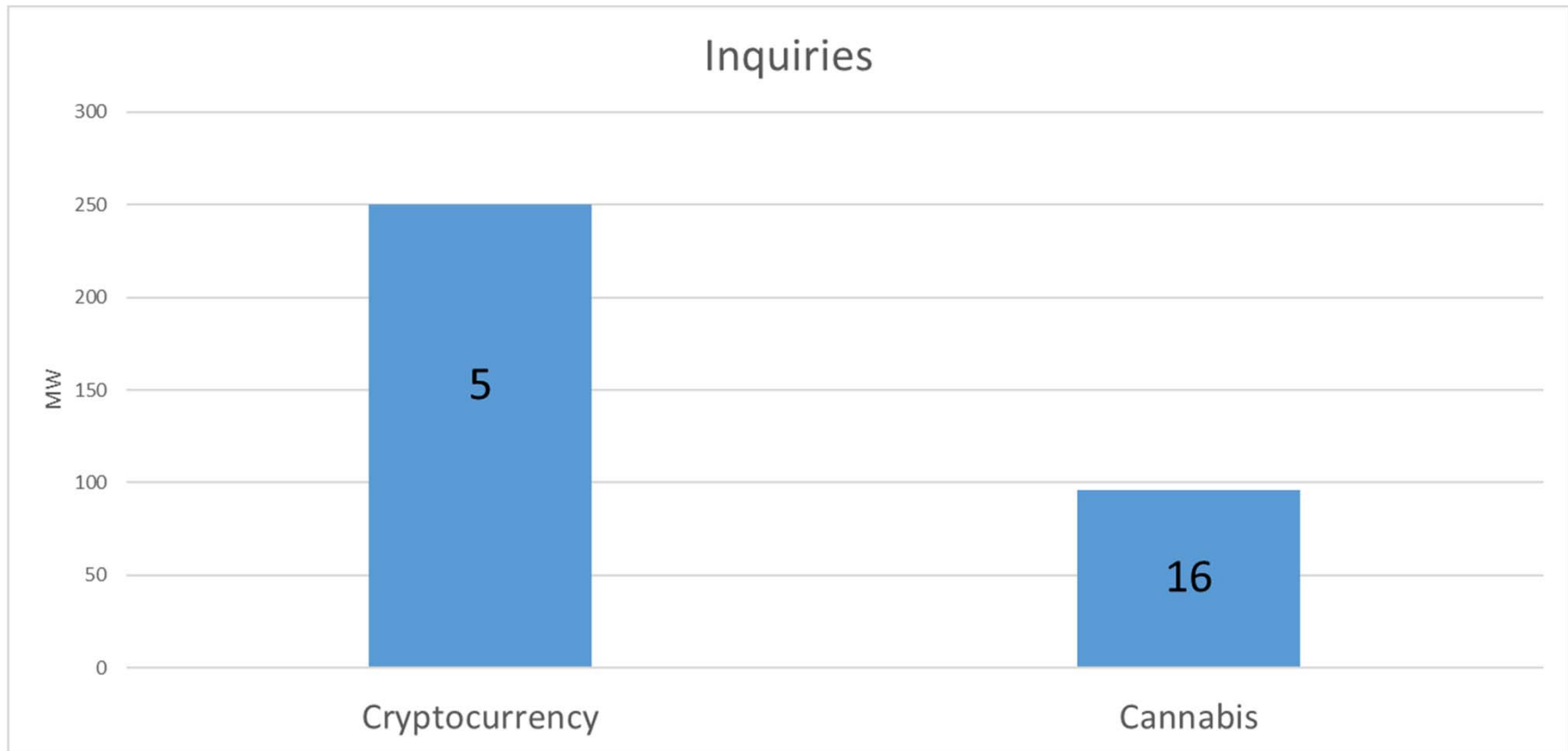
Total Hours, Sessions and kWh by Month



Distributed Generation Growth

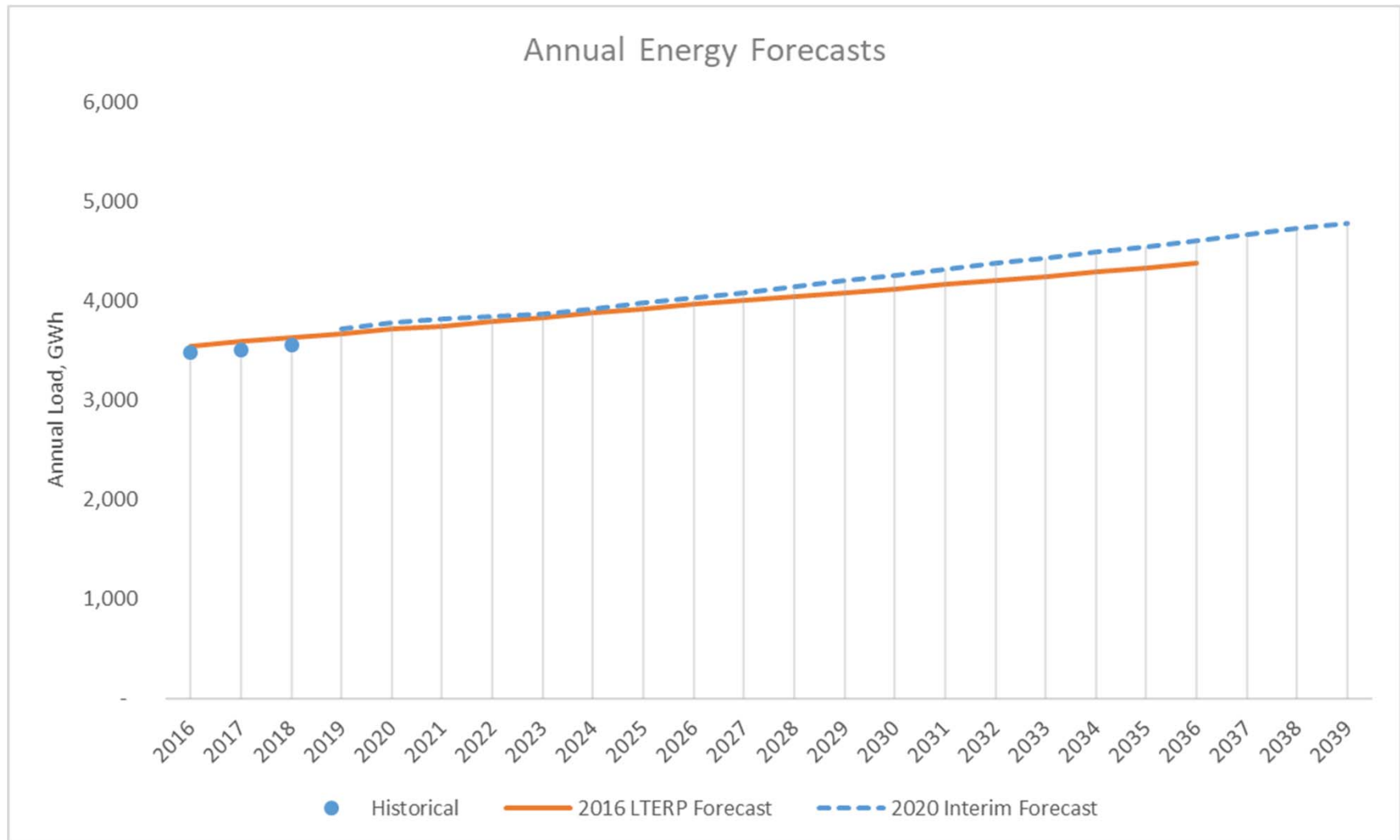


Cannabis & Cryptocurrency Inquiries

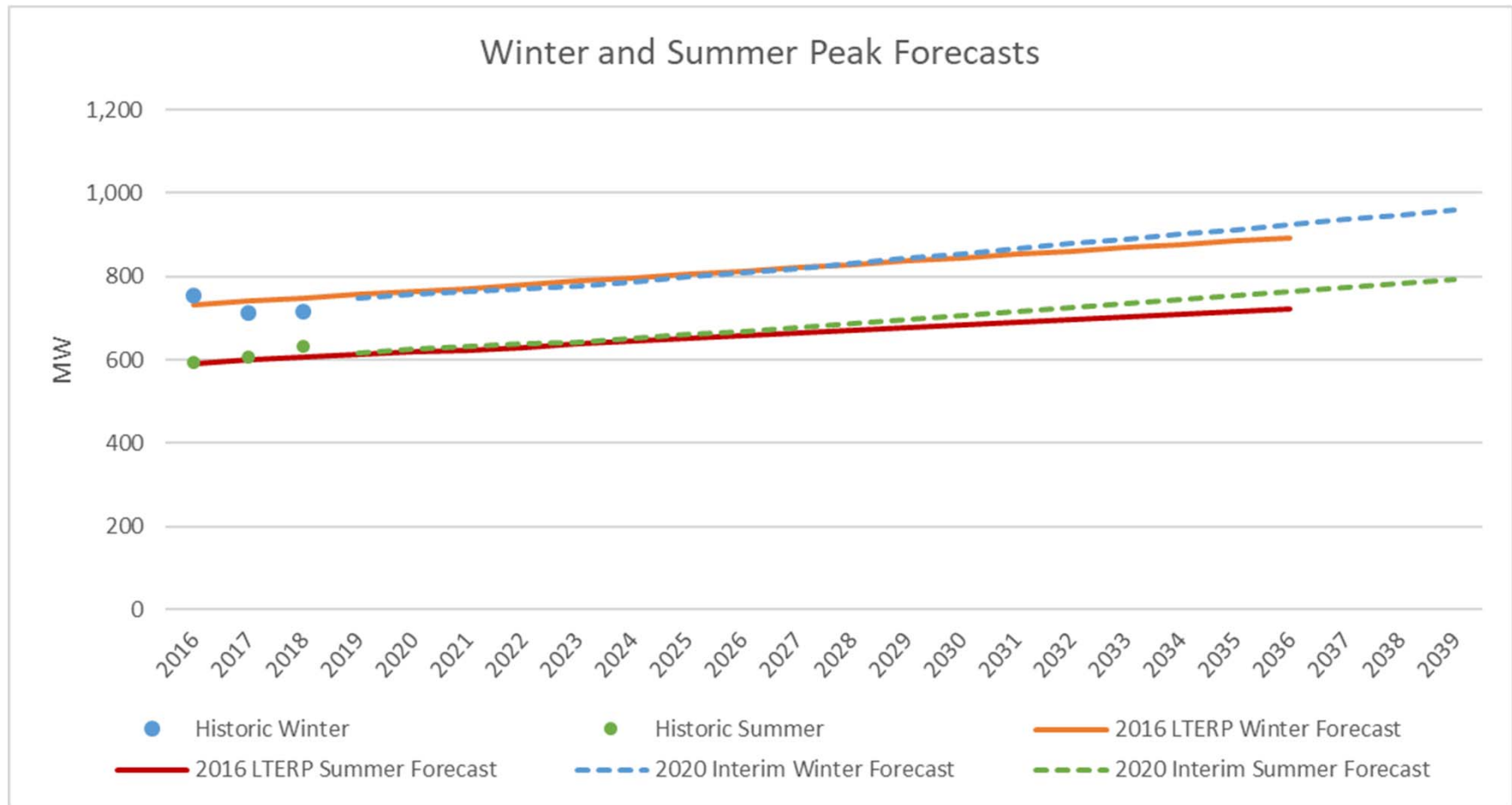


- Current FBC winter peak capacity requirement ~ 730 MW

Annual Energy Load Forecast Update



Peak Forecast Update



Questions?

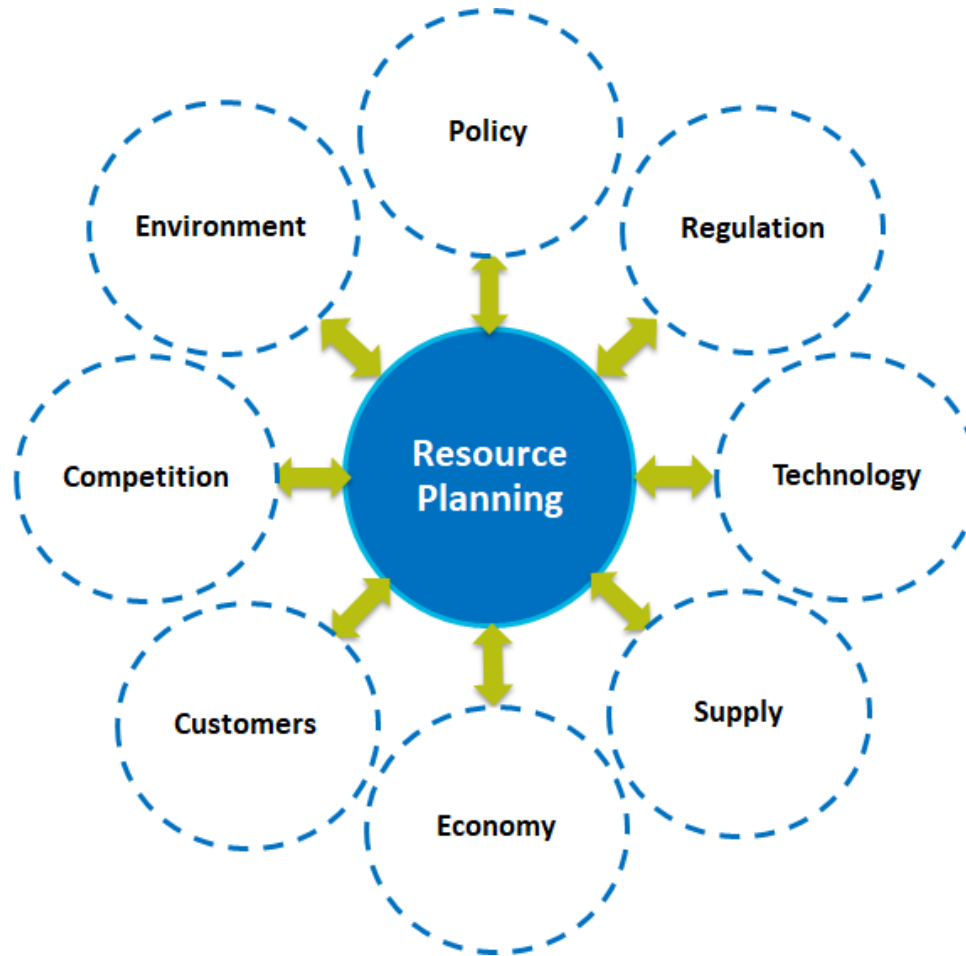
Planning Environment

Dan Egolf

Senior Manager, Power Supply & Planning

Planning Environment

Factors that influence long term planning analysis and decisions



- Planning horizon: 2021 - 2040



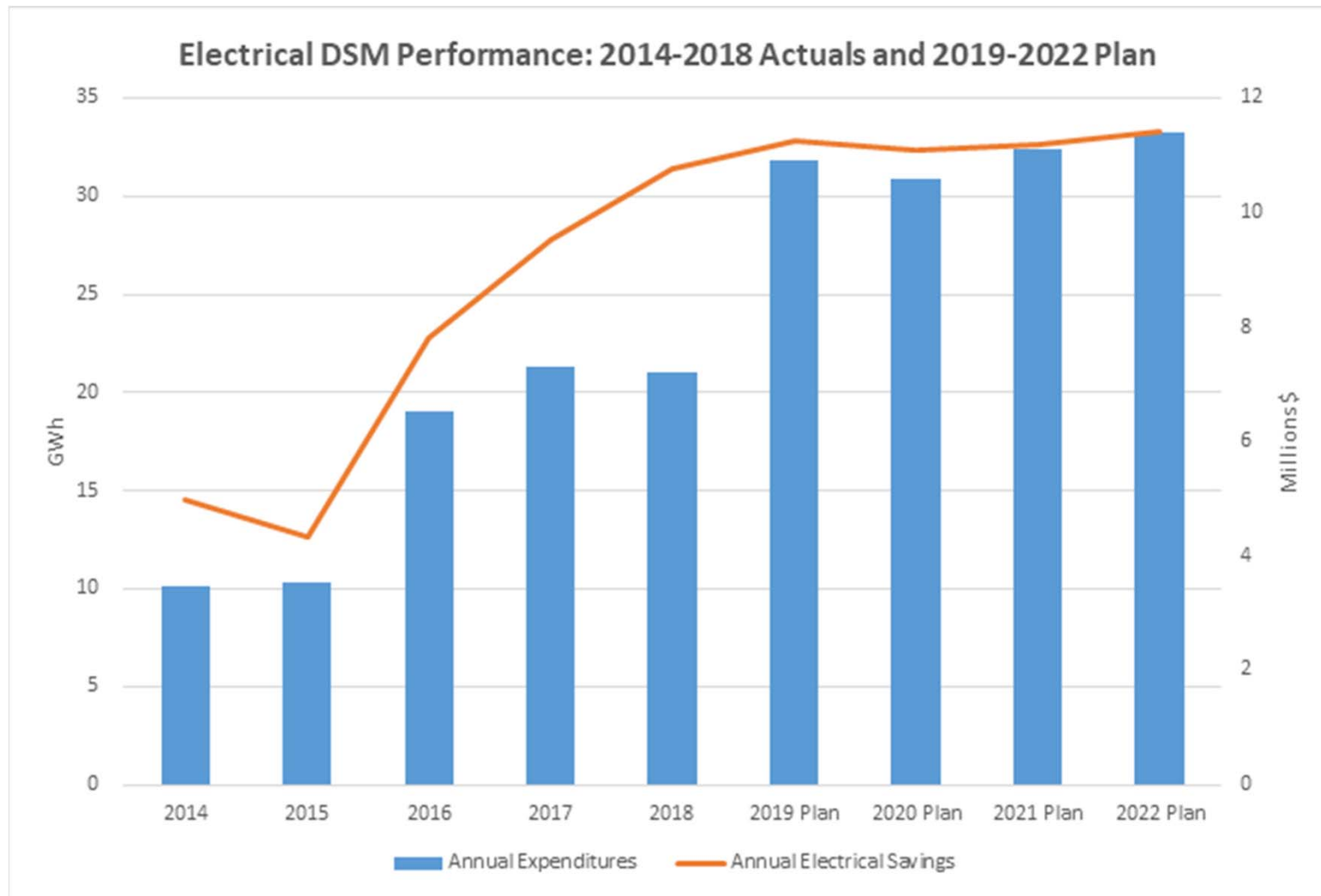
Policies aimed at reducing GHG emissions

- Zero emission vehicle targets
- Cleaner transportation fuels
- More efficient buildings
- Electric heat pump incentives
- 15% renewable gas target





Strong Focus on DSM





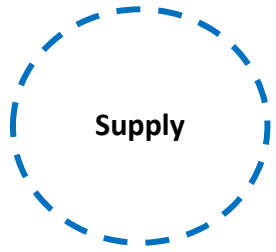
Potential for Faster Load Growth





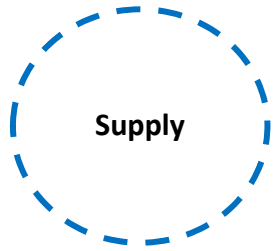
Connected Home and Business





Declining costs for wind, solar, batteries

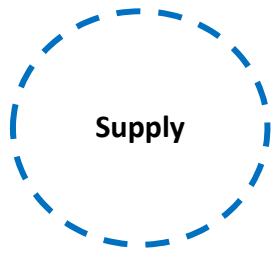




BC Hydro Developments

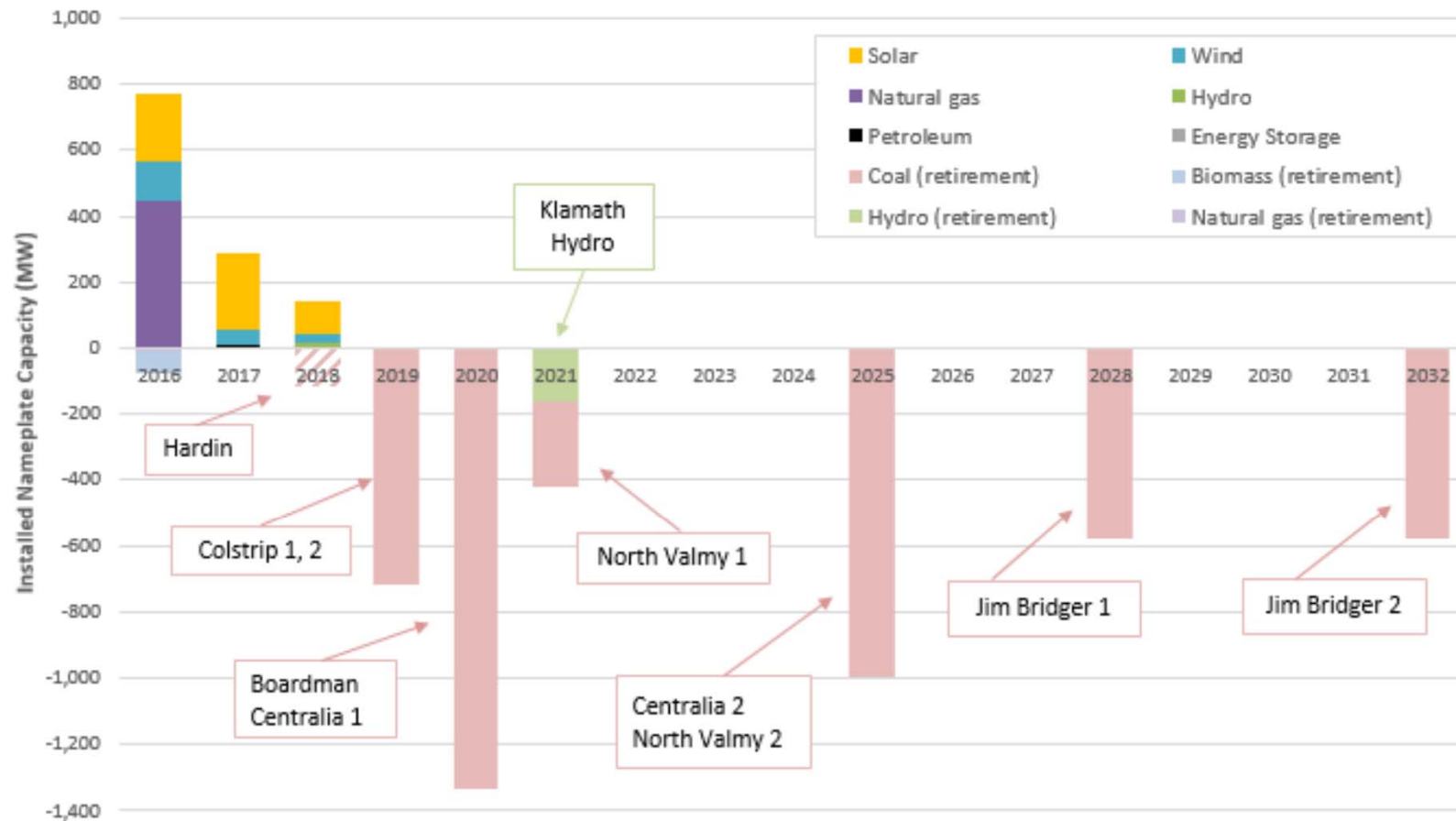


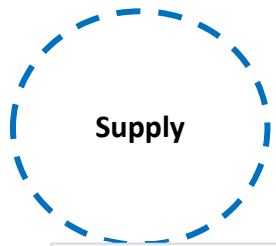
- Site C surplus?
- Expiring EPAs
- FortisBC PPA
- Electrification loads



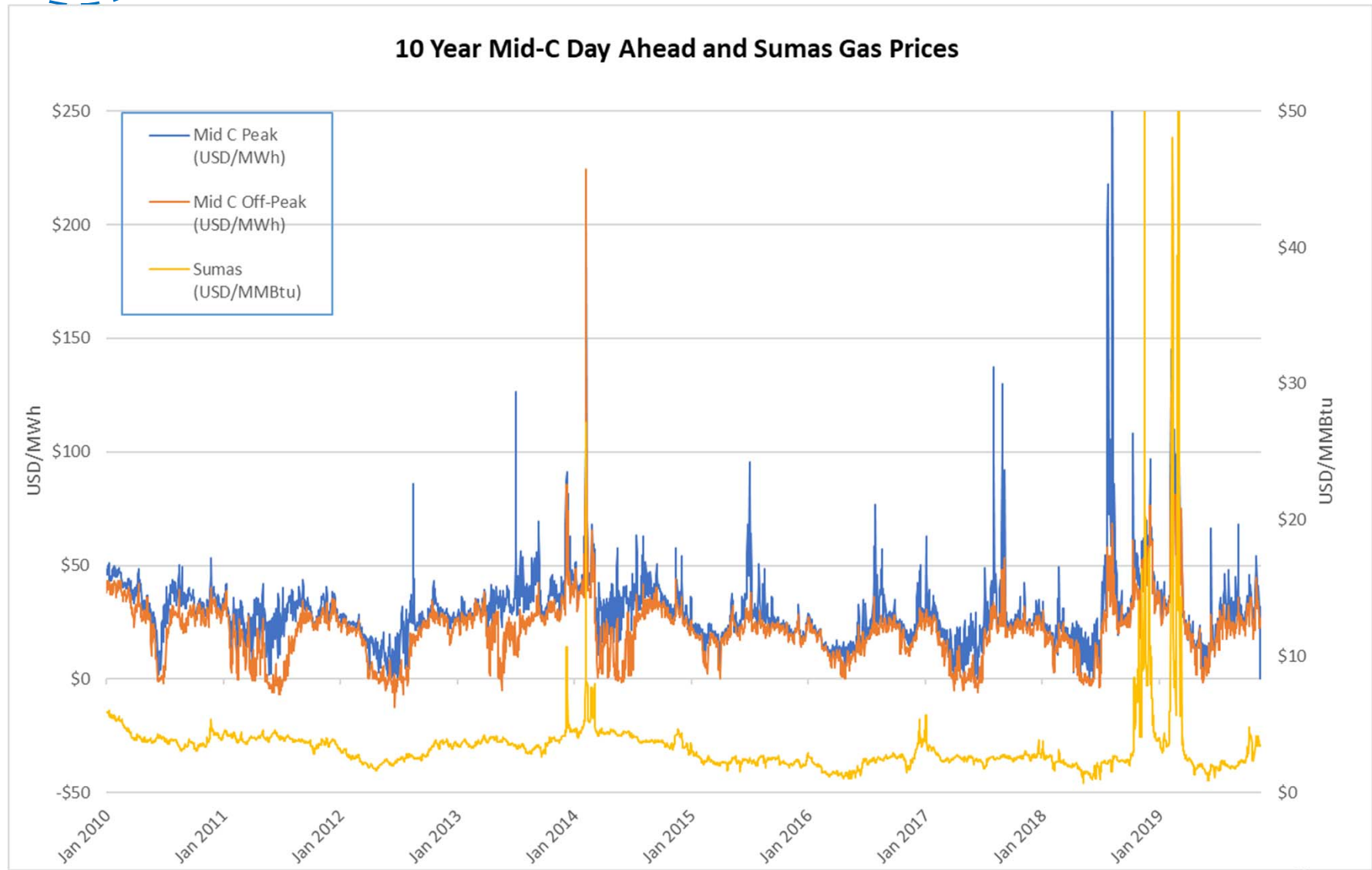
Regional Resource Adequacy Concerns

Additions and Retirements since the Seventh Power Plan
(incl. announced planned retirements)





Gas & power prices generally low





Water Management

- Columbia River Treaty
- Kootenay Lake management
- Impacts to FBC generation
- Climate change





Climate Change – California example



What are the long term impacts on utilities and customers?

Questions?

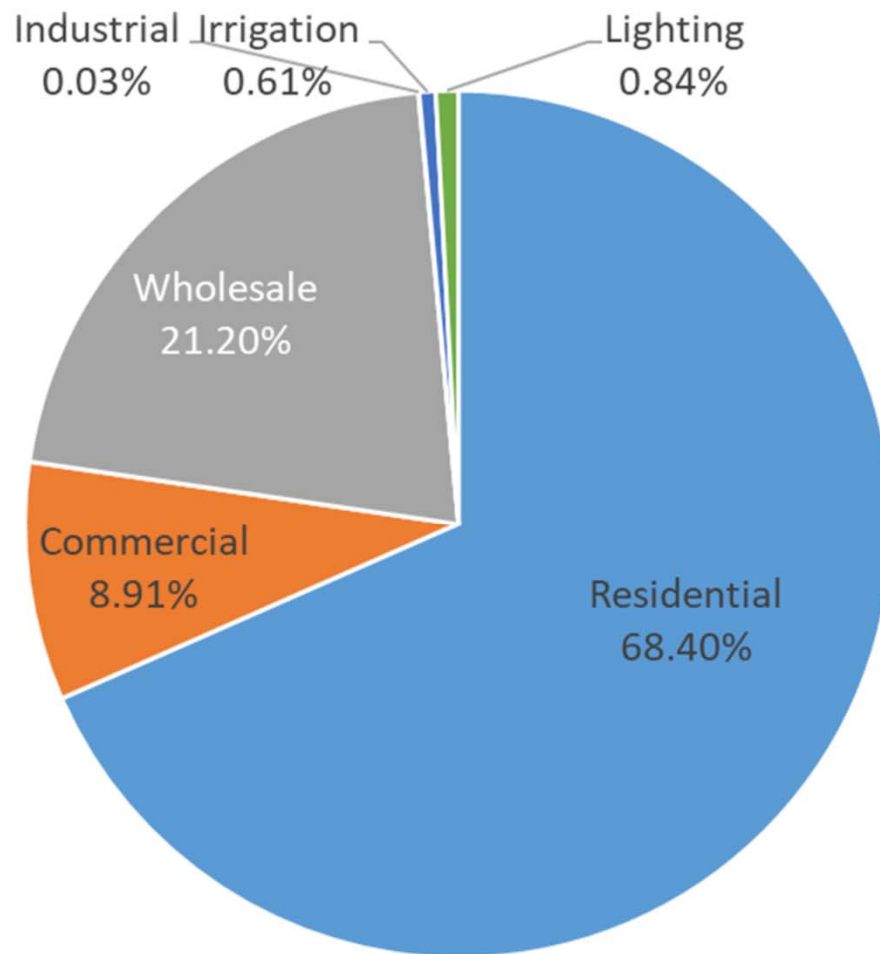
Load Forecasting

David Bailey, P.Eng.

Customer Energy & Forecasting Manager

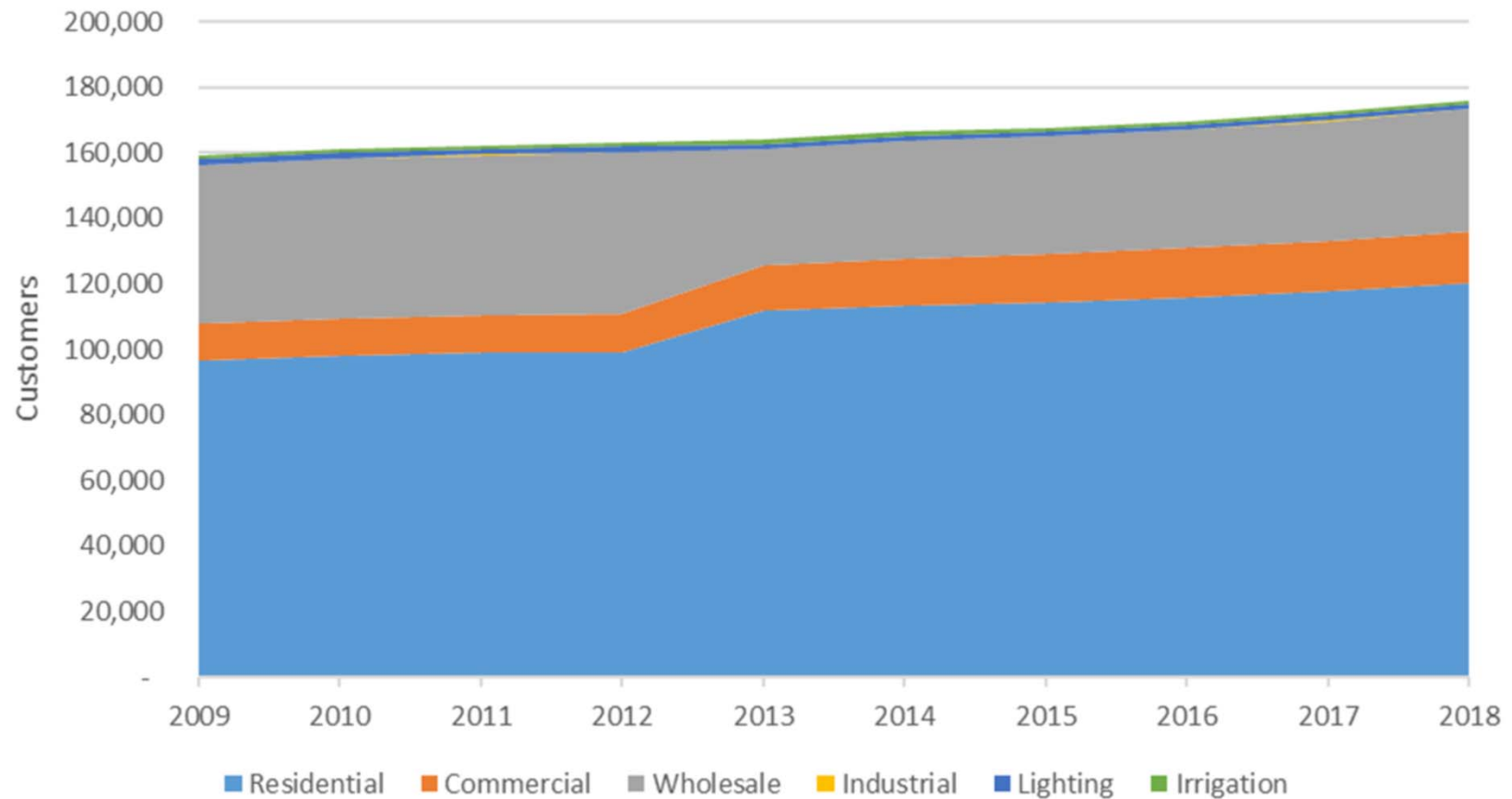
Customer Profile and Trends

FBC Customer Mix - 2018

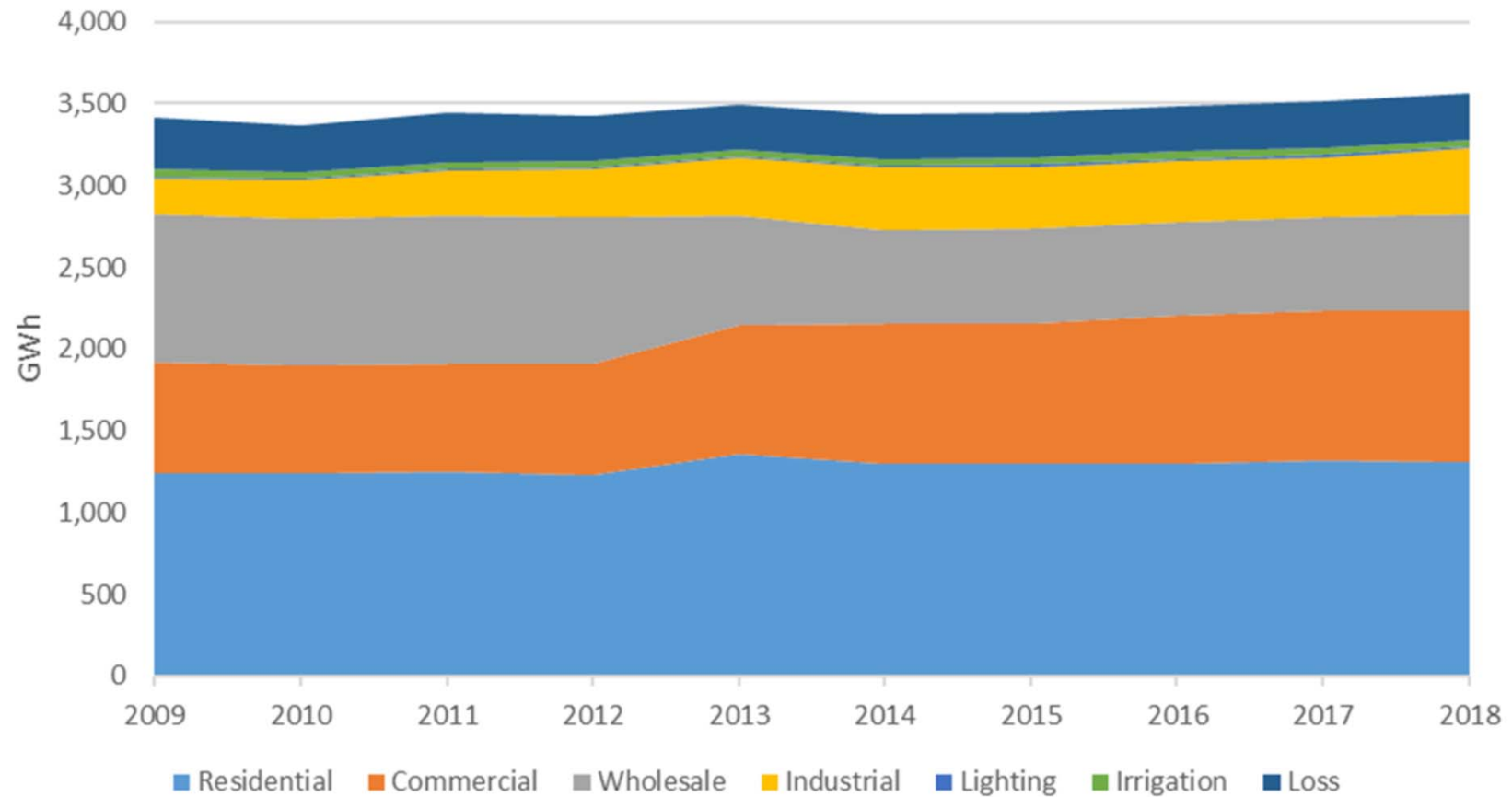


- Primarily residential
- 52 industrials
- 6 wholesale customers account for 37,300 indirect customers
- Very similar to 2016

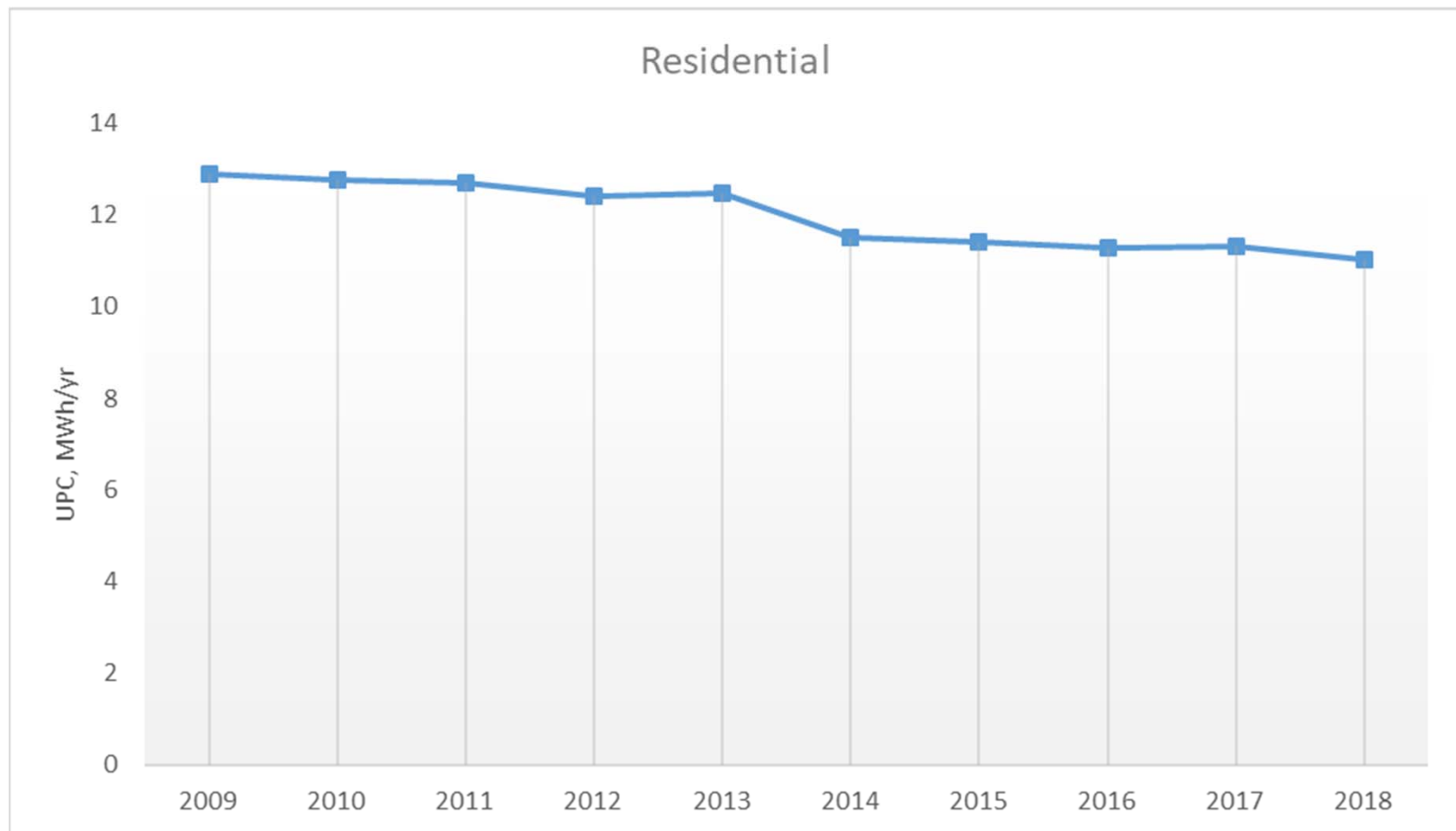
10 Years of Customer Growth



10 Years of Energy Growth



Residential Use Rate



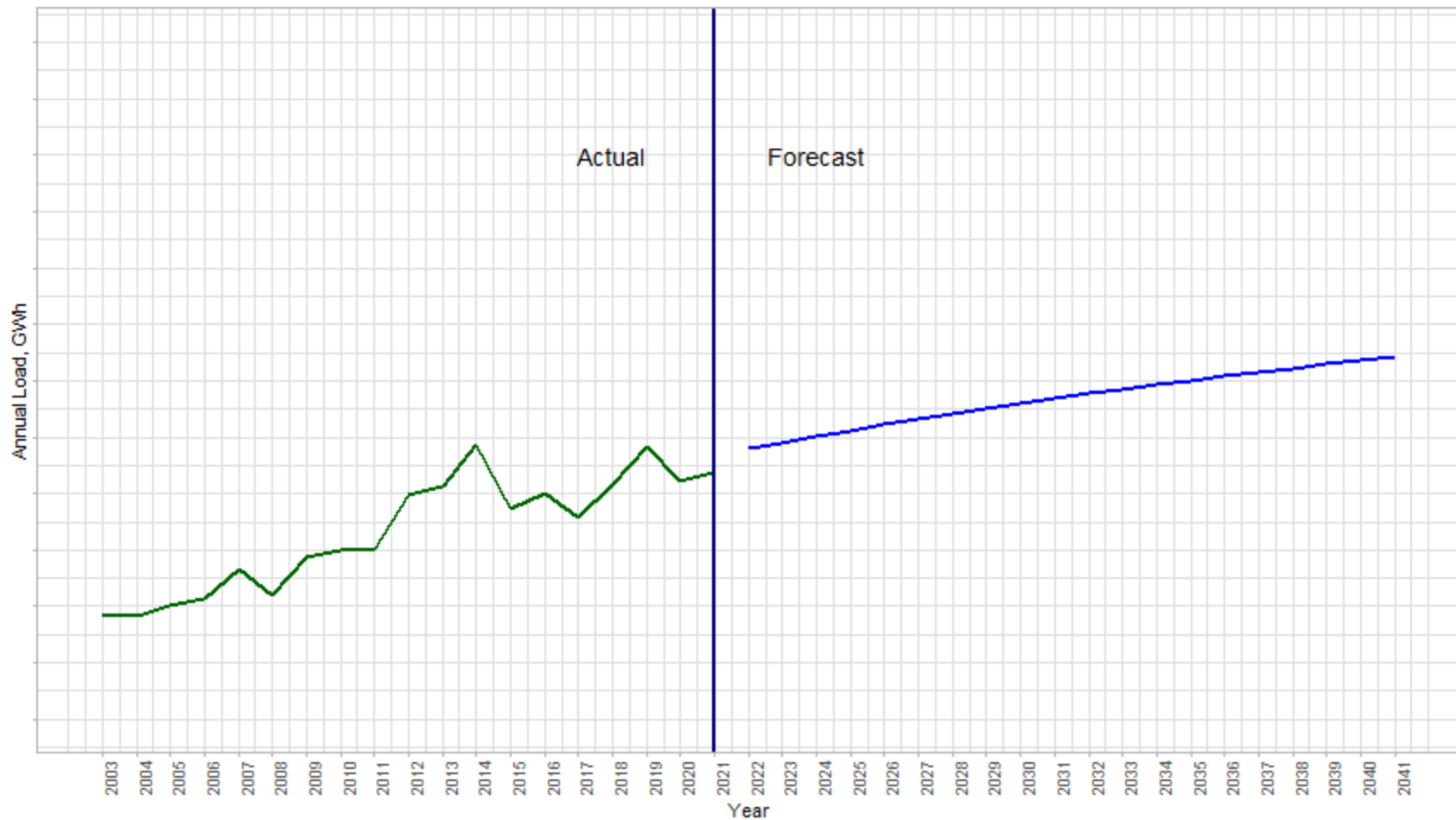
Load Forecasting Approach

Taxonomy of Long Term Annual Demand Forecasts

	LTERP	Description
Business as Usual	Method: Time series Prepared by: FBC Forecasting	<ul style="list-style-type: none"> • Extensions of the annual revenue forecast methods. • Formerly called <i>Reference Case</i> in the LTERP. • The volatility of the inputs to this forecast are used to develop the confidence intervals.
Reference Case	Method: Consultant research Prepared by: Consultant/FBC	<ul style="list-style-type: none"> • This adds <u>any future changes that are certain</u> (e.g. laws that are enshrined & whose implementation path is clear) on the BAU. • Portions may be subjective, but supported with evidence. • This is the “planning scenario”.
Scenarios	Method: Consultant research Prepared by: Consultant/FBC	<ul style="list-style-type: none"> • Layered on the BAU. • Two special scenarios are the Upper Boundary and Lower Boundary. • Additional scenarios describe future worlds.
Stakeholder Scenarios	Method: Crowd forecast / slider Prepared by: Stakeholders	<ul style="list-style-type: none"> • The stakeholder version of the Reference Case. • Average the stakeholder forecasts to create a consensus forecast. • Layer the consensus forecast on the BAU .

Load Forecast & Scenarios

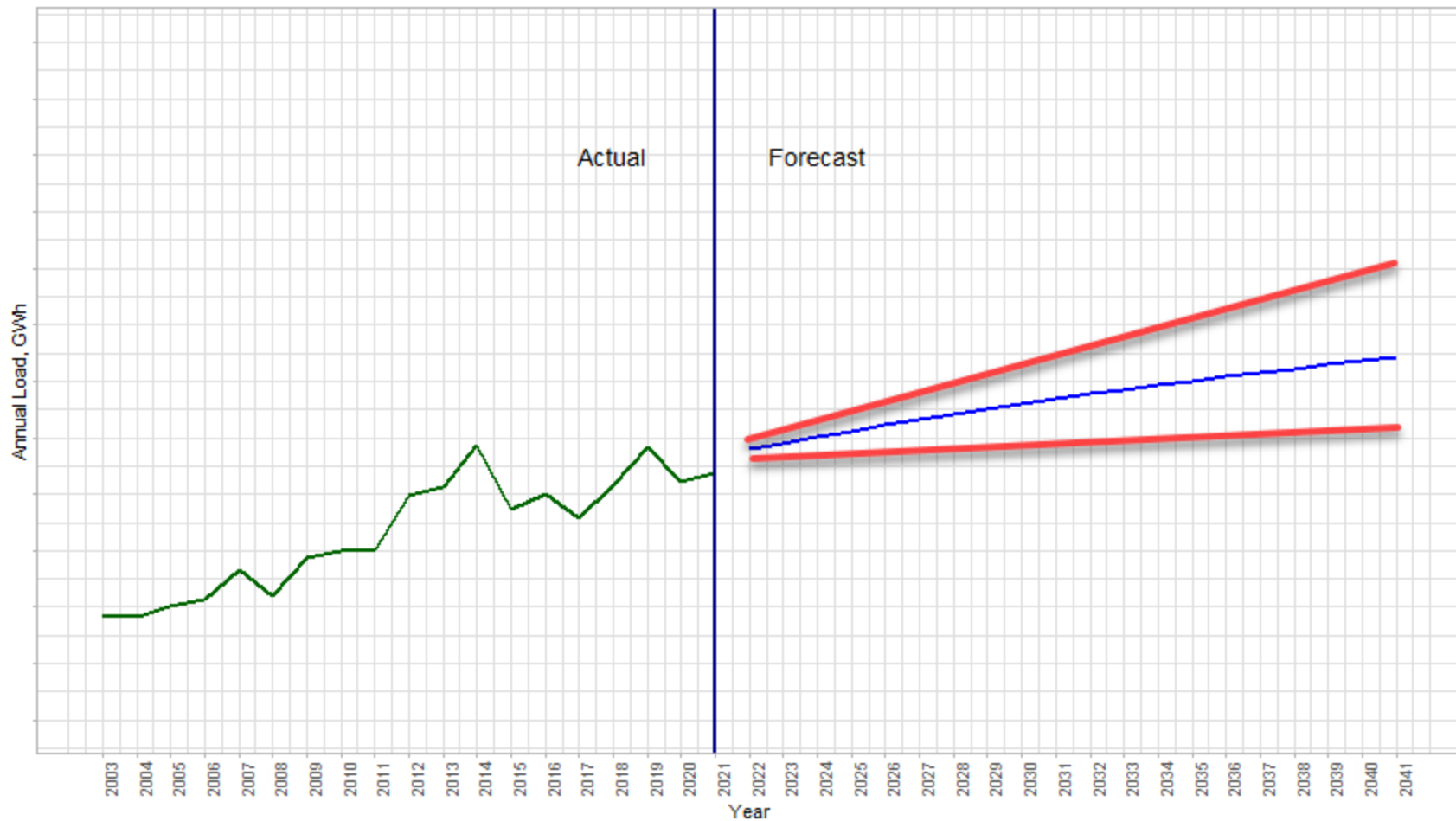
Business as Usual



All data is fictitious and used for demonstration purposes only.

Load Forecast & Scenarios

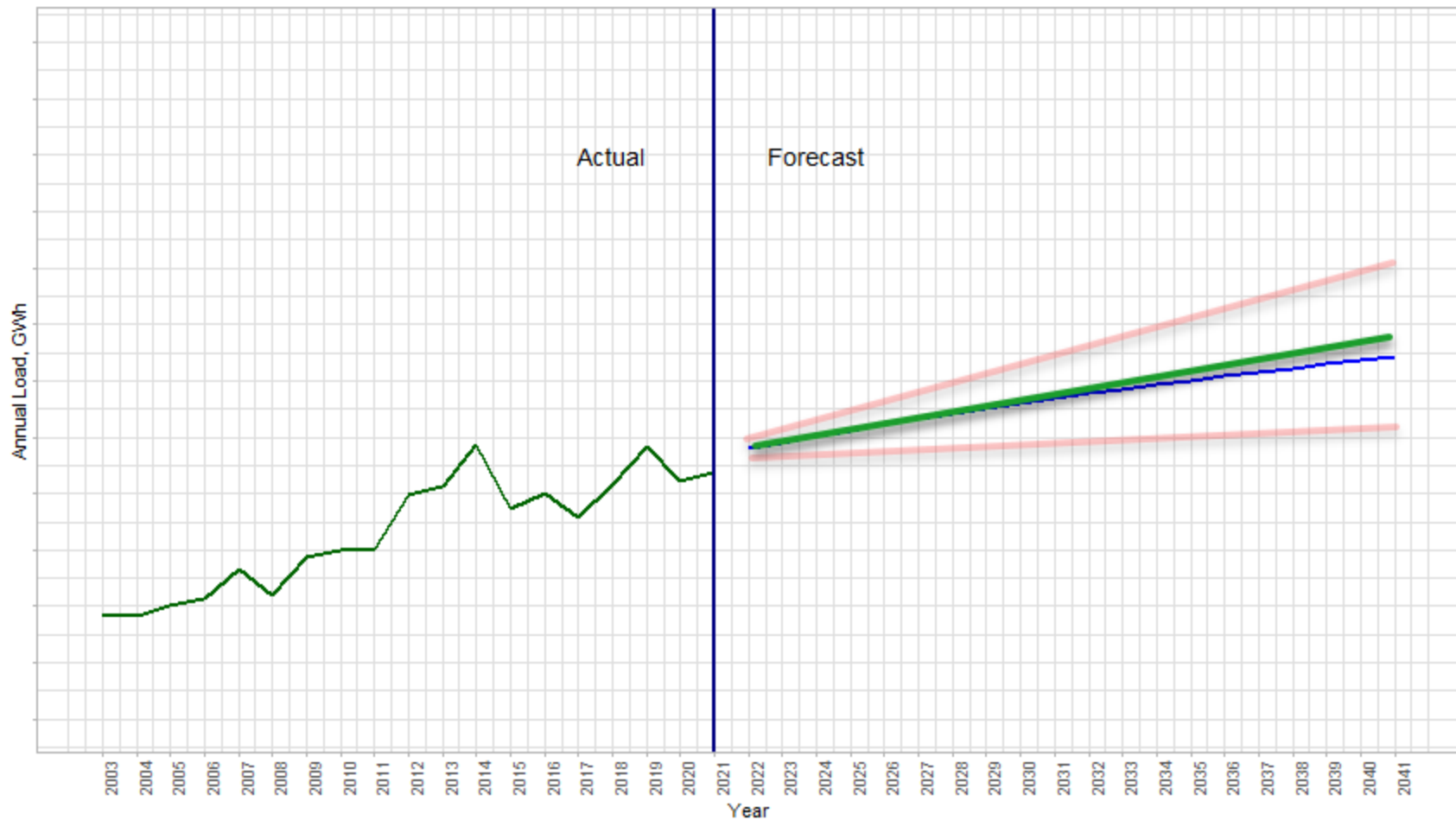
Business as Usual with Confidence Intervals



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Load Forecast & Scenarios

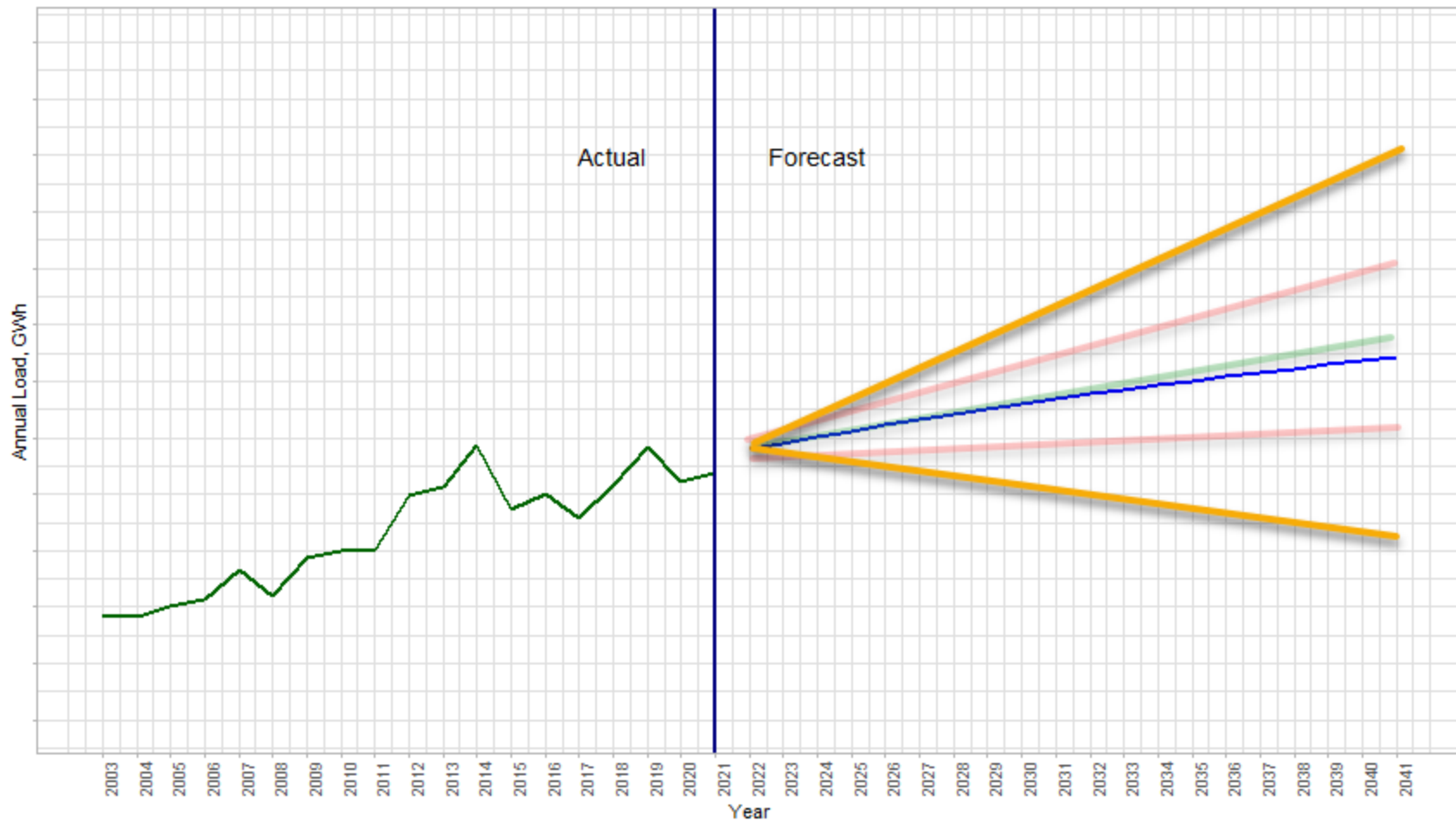
Reference Case



All data is fictitious and used for demonstration purposes only.

Load Forecast & Scenarios

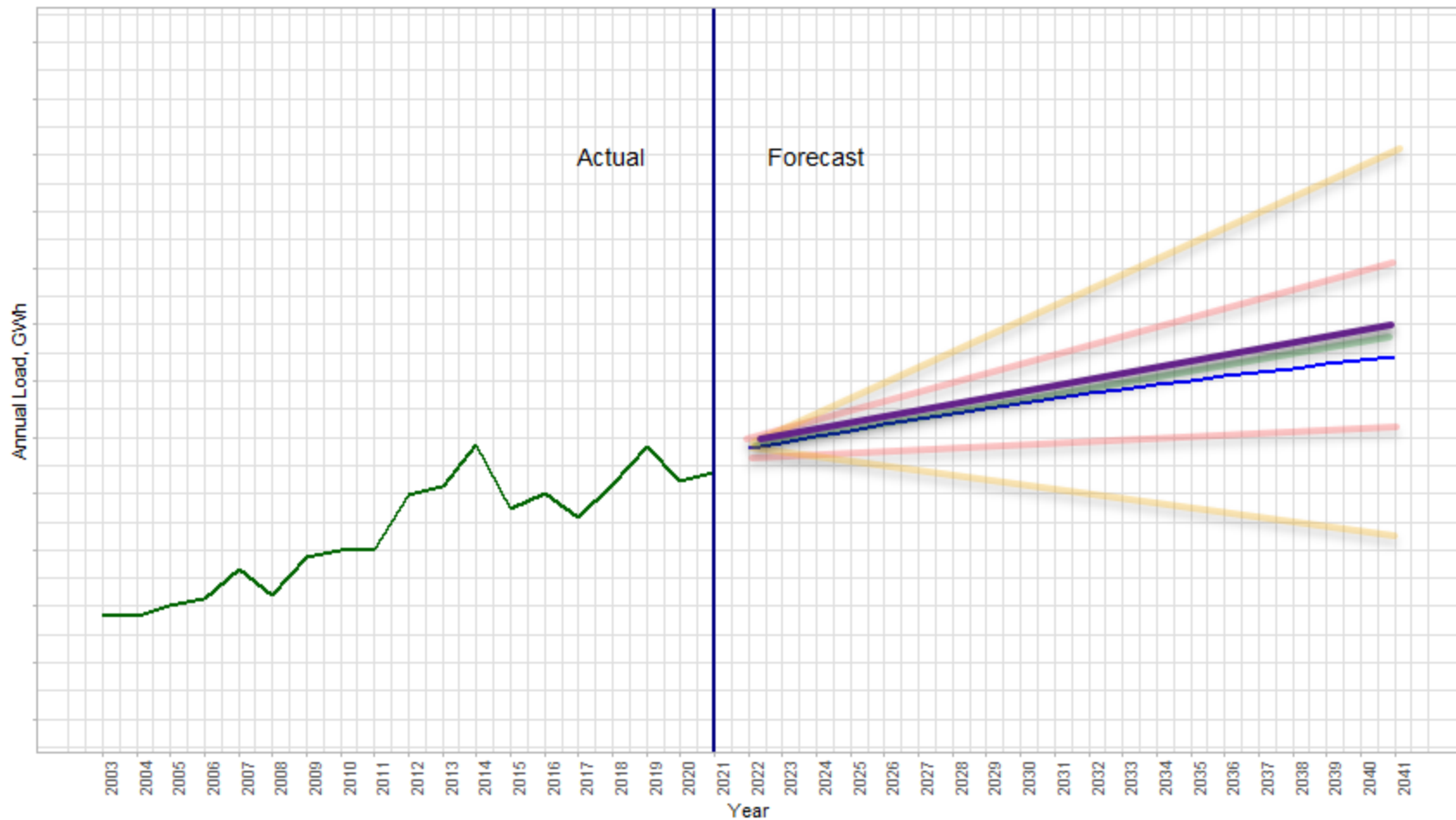
Consultant Upper and Lower Boundary Scenarios



All data is fictitious and used for demonstration purposes only.

Load Forecast & Scenarios

Stakeholder Reference Case



All data is fictitious and used for demonstration purposes only.

Business as Usual Overview



Residential

- Customers: Regression of BC STATS population
- UPC: Regression of normalized actuals
- Load: Product of customers and UPC



Commercial

- Load and Customers: Regression of CBOC GDP



Industrial

- Survey



Wholesale

- Survey



Lighting

- Load and Customers: If a trend exists then regression, otherwise average



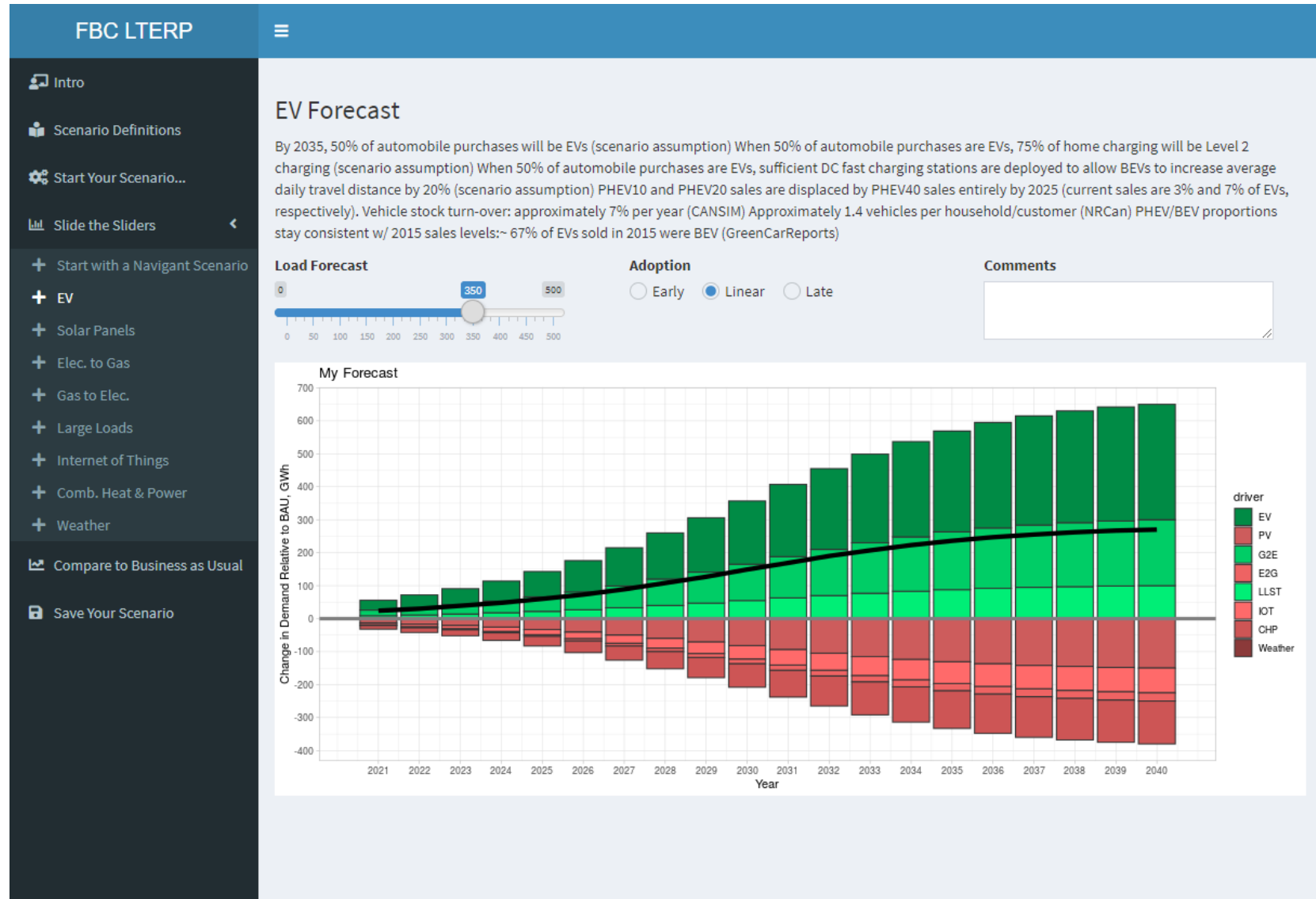
Irrigation

- Load and customers: 5 year average

Reference Case Considerations

- What FBC will be considering:
 - ZEV mandate
 - Level and applicability to FBC service territory
 - Cryptocurrency and cannabis commitments
 - Other large loads that firm up, but are not online

Stakeholder Reference Case



Questions?

Load Drivers & Scenarios

Mike Hopkins

Senior Manager, Price Risk & Resource Planning

Peter-Steele Mosey

Associate Director, Navigant

What are Load Drivers?

- External factors that increase or decrease customer loads
 - e.g. EV charging, rooftop solar
- Different combinations included in scenarios



What are Load Scenarios?

- Define possible future states of the world
- Capture uncertainty in load forecasts
- Include impacts of different mixes of load drivers
- Can be updated again in future LTERPs with latest info

Why Load Scenarios?

- Prudent part of long term resource planning
 - We are on the verge of some potentially significant changes in energy use and technology - e.g. distributed generation, electric vehicles
 - Framework for any future infrastructure requests, initiatives, resources
 - Informs flexibility and contingency planning requirements
- *BCUC Resource Planning Guidelines* include developing a range of gross (pre-DSM) demand forecasts

FORTISBC LOAD SCENARIO DEVELOPMENT

STAKEHOLDER WORKSHOP: LOAD DRIVERS AND LOAD SCENARIOS

2019-11-26



NAVIGANT
A Guidehouse Company

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1. OVERVIEW AND GOALS FOR THIS MEETING

OVERVIEW AND GOALS FOR THIS MEETING

Navigant (a Guidehouse Company) is supporting FortisBC in the development of a set of potential future load scenarios to explore the potential impact of structural changes in future utility loads.

- Navigant carried out a similar engagement in 2015/2016 for FortisBC
- The drivers and scenarios presented today represent the outcome of a series of discussions between Navigant staff and FortisBC's internal team of experts



The primary goals of this meeting are:

- Discuss and get feedback on the 9 load drivers to be used in scenario modeling
- Discuss and get feedback on the 5 scenarios used for modeling



2. LOAD DRIVERS

LOAD DRIVERS



1. Integrated Photovoltaic Solar and Storage (IPSS) – Residential

Residential rooftop solar photovoltaic (PV) installations, in some cases supported by energy storage.



2. Integrated Photovoltaic Solar and Storage (IPSS) – Commercial

Commercial building solar photovoltaic (PV) installations, in some cases supported by energy storage.



3. Electric Vehicles (EV)

- Light duty vehicles (LDV) including: plug-in hybrids (PHEV) and battery electric vehicles (BEV)
- Medium and heavy duty vehicles (MHDV) including: return-to-base fleet vehicles, busses, combination tractors



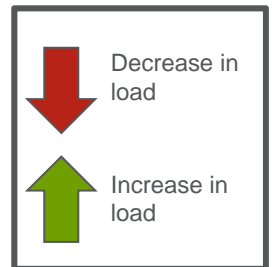
4. Fuel Switching: Gas to Electric (FS G2E)

- Electrification of residential space- and water-heating
- Equipment to reflect the mix of equipment projected in the Technical Potential estimated as part of the Conservation Potential Review (June 2019)



5. Fuel Switching: Electric to Gas (FS E2G)

Replacement of non-heat pump electric residential space- and water- heating with standard efficiency (code-compliant) natural gas fired equipment.



LOAD DRIVERS



6. Climate Change (CC)

Increasing average annual temperatures reduce heating loads in the winter and increase cooling loads in the summer. Net effect is reduction in energy consumption.



7. Large Load Sector Transformation (LLST)

Transformation of the large commercial and industrial (C&I) sector. Specifically: significant growth in the number of data centres and cannabis greenhouses in FortisBC territory.



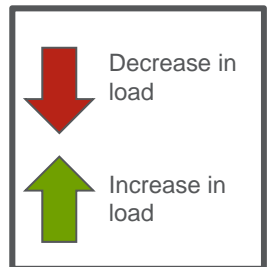
8. Hydrogen and Synthetic Methane Production (HSMP)

Electricity consumption driven by the production of “green” hydrogen and synthetic methane (key ingredients for renewable gas).



9. Carbon Capture and Storage (CCS)

Electricity consumption driven by power requirements of CCS technologies used to capture carbon emissions *in situ* from industrial processes





3. LOAD SCENARIOS

LOAD SCENARIOS



1. Upper Bound

Includes only load drivers that increase load. Ultimate penetration of all included load drivers set to reasonable extreme.



2. Lower Bound

Includes only load drivers that decrease load. Ultimate penetration of all included load drivers set to reasonable extreme.



3. Deep Electrification

Electrification of transportation, residential and commercial space and water heating and industrial process heating. Growth in IPSS (commercial and residential) to support electrification.



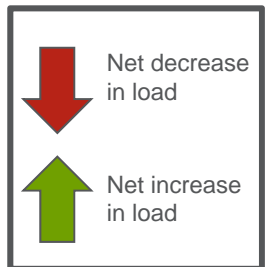
4. Diversified Energy Pathway

Emissions reductions characterized more by decarbonization of fuels than electrification. Includes significant increases in HSMP, supported by CCS. Surplus generation helps motivate LLST and adoption of EVs.



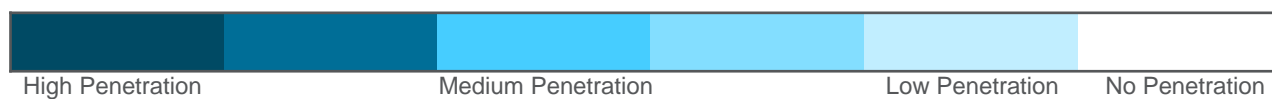
5. Distributed Energy Future

The falling costs of renewable generation and storage drives growth in residential and commercial IPSS. Increased self-generation reduces utility revenue, increasing retail rates and provoking some E2G fuel switching. Growth in HSMP and CCS to support growth in NG requirements.



LOAD SCENARIOS AND DRIVERS

Drivers Scenarios	IPSS (Res)	IPSS (Com)	EVs	FS G2E	FS E2G	CC	LLST	HSMP	CCS
Upper Bound									
Lower Bound									
Deep Electrification									
Diversified Energy Pathway									
Distributed Energy Future									





APPENDIX A: LOAD SCENARIO PROFILES

UPPER BOUND

Description

The Upper Bound scenario exists to help FortisBC understand the upper limit of the potential impacts on energy consumption of structural changes in the drivers of electric load. This scenario only includes load drivers that increase load. All load drivers' ultimate penetration (where appropriate) assumed at highest levels ("reasonable extremes"). This scenario has a net **increase** in load.

Drivers

Driver	Impact
EVs	Electric vehicles are adopted at the highest levels technically feasible (i.e. all new sales are EVs) and economically feasible (given incentives, technology cost declines and electricity prices).
FS G2E	Significant fuel switch of existing gas space and water heating to high electric space and water heating. Fuel switching aligns with the technical potential from the CPR.
LLST	Rapid increase in the number of highly energy-intensive sectors.
HSMP	Large increase in production of green hydrogen and synthetic methane (key ingredients for renewable gas).
CCS	Increased production of renewable gas requires uptake of carbon capture and storage.

Influences

Economics and Technology	Policy
Energy storage, electrolysis, CCS and electric heat pump costs fall rapidly.	Electrification cemented as centerpiece of emissions reduction strategy .
Falling equipment costs make EVs more attractive as an investment than internal combustion engine vehicles. Network effects and investment in charging infrastructure effectively eliminates range anxiety..	Cannabis production booms, BC enacts policy to incentivize large electricity load customers to enter province (data centres). Production of renewable gas and a shift away from fossil natural gas is needed to meet emissions targets.

The Upper Bound scenario is designed to push the boundaries of reasonable extremes such that it represents the absolute maximum load that could possibly happen given the modeled load drivers. The narrative for this scenario reflects the extremes to which the load drivers must be pushed to achieve the Upper Bound.

LOWER BOUND

Description

The Lower Bound scenario exists to help FortisBC understand the lower limit of the potential impacts on energy consumption of structural changes in the drivers of electric load. This scenario only includes load drivers that decrease load. All load drivers' ultimate penetration (where appropriate) assumed at highest levels ("reasonable extremes"). This scenario has a net **decrease** in load.

Drivers

Driver	Impact
IPSS – Res	Solar PV is deployed at the highest levels technically feasible (i.e. all homes/buildings with a roof, yard/property visible to the sun) and economically feasible (given incentives, technology cost declines and electricity prices).
IPSS – C&I	
FS E2G	Significant fuel switch of existing electric space and water heating to high efficiency gas space and water heating.
Climate Change	Increasing average temperatures reduce thermal loads in the winter and increase them in the summer. Net effect is a load reduction.

Influences

Economics and Technology	Policy
Solar costs continue to fall rapidly, electricity prices increase incentivizing self-generation and de-electrification.	Electrification assessed as insufficiently cost-effective for major incentives.
Energy storage costs fall much faster for stationary than for mobile applications.	Rising electricity costs discourage public funding for RNG production.

The Lower Bound scenario is designed to push the boundaries of reasonable extremes such that it represents the absolute minimum load that could possibly happen given the modeled load drivers. The narrative for this scenario reflects the extremes to which the load drivers must be pushed to achieve the Lower Bound.

DEEP ELECTRIFICATION



Description

Electrification of transportation, residential and commercial space and water heating. Growth in IPSS to support electrification. This scenario has a net **increase** in load.

Drivers

Driver	Impact
IPSS	Solar PV and energy storage are deployed at a high rate to assist with electrification.
IPSS C&I	
EVs	LD Electric vehicles are adopted at the rate defined in the ZEV mandate, which is expanded to include MHDVs, pushing their adoption considerably.
FS G2E	Significant fuel switch of existing gas space and water heating to a mix of high efficiency electric space and water heating.
Climate Change	Increasing average temperatures reduce thermal loads in the winter and increase them in the summer. Net effect is a load reduction, lower than the impact modeled in the Lower Bound.

Influences

Economics and Technology	Policy
Solar and storage costs continue to fall rapidly.	The ZEV mandate is expanded to include MHDV vehicles.
New charging infrastructure reduces EV range anxiety. Falling storage costs make EVs increasingly attractive.	Electrification and a shift away from natural gas are key cornerstones in order to meet emission goals.
	A climate emergency is declared in several BC municipalities pushing a focus on reducing greenhouse gas emissions.

DIVERSIFIED ENERGY PATHWAY

Description

Increases in green hydrogen and synthetic methane production, CCS, and conversion of residential and commercial electric heating (space and water to gas). Large load sector transformation, perhaps motivated by surplus electricity generating capacity. Emissions reductions characterized more by decarbonization of fuels than electrification. This scenario has a net **decrease** in load.

Drivers

Driver	Impact
FS E2G	A significant percentage of existing electric heating is switched to high efficiency gas heat pumps. New buildings primarily heated with gas or hybrid heat pumps.
EVs	LDVs meet ZEV mandate, which is not extended to cover MHDVs.
HSMP	The majority of the natural gas mix by volume is made up of hydrogen, renewable natural gas and synthetic methane. The production of hydrogen increases electricity demand.
CCS	Significant CCS is needed to reduce emissions from industry, blue hydrogen production. Levels of CCS will be significantly higher than projections from CleanBC.
LLST	A surplus in electricity generation leads to a large load increase from customers such as data centres or cannabis greenhouses.
Climate Change	Increasing average temperatures reduce thermal loads in the winter and increase them in the summer. Net effect is a load reduction, lower than the impact modeled in the Lower Bound.

Influences

Economics and Technology	Policy
Blue hydrogen (e.g. natural gas reformation) is replaced over the forecast by green hydrogen (electrolysis) as primary hydrogen technology due to declining costs of the latter.	Government designs policy in a manner that protects existing gas infrastructure to avoid underutilized gas capacity.
Gas heat pump technology costs decline to near parity of electric heat pumps.	Policy-mandated incentives are provided to customers to increase adoption of low carbon gases and gas heat pumps.

DISTRIBUTED ENERGY FUTURE

Description

The falling costs of renewable generation and storage drives growth in residential and commercial IPSS. Increased self-generation reduces utility revenue, increasing retail rates and provoking some E2G fuel switching. Growth in HSMP and CCS to support growth in natural gas requirements. This scenario has a net **decrease** in load.

Drivers

Driver	Impact
IPSS – Res	IPSS is seen as a economical alternative to grid power. Significant proportions of communities and commercial/industrial businesses switch over to IPSS, using the existing grid only as a backup.
IPSS – C&I	
Climate Change	Increasing average temperatures reduce thermal loads in the winter and increase them in the summer. Net effect is a load reduction, lower than the impact modeled in the Lower Bound.
FS E2G	High efficiency gas or hybrid heat pumps are favoured in new builds, as they pose lower lifetime energy costs for residents and businesses.
HSMP	Increased production of renewable gas is needed to meet the growing need for natural gas.
CCS	In order to support the growth of HSMP, CCS is needed.
EVs	EV growth lower than expected (or mandated in ZEV) in response to increasing rates.

Influences

Economics and Technology	Policy
Solar PV costs continue to fall rapidly, electricity prices increase significantly.	Decreasing consumption volumes increase system fixed costs per kWh consumed; additional solar (not all supported by storage) requires additional investments in support infrastructure.
Natural gas prices track historical trends (increase slowly).	
Efficient natural gas end uses, hydrogen and CCS costs decline.	BC continues to disallow development of natural gas power generation to meet peak demand requirements, indicating that relatively higher priced renewables and storage are needed to meet peak.



APPENDIX B: LOAD DRIVER PROFILES

These load profiles represent Navigant's initial research and are likely to evolve based on stakeholder and FortisBC feedback, as well as information uncovered as part of further research.

INTEGRATED PHOTOVOLTAIC SOLAR STORAGE SYSTEMS (IPSS) - RESIDENTIAL



Description

Solar photovoltaic (PV) installations can be supported by energy storage, sometimes known as IPSS. As much of the given home's electricity consumption as possible is satisfied by PV output, output exceeding this is stored, to be discharged as solar output falls. Excess production beyond household and storage needs is returned to the grid. This load driver will **decrease** load.

Characterisation Approach

- **Develop PV output profile:**
 - Monthly Output: Determine average home system capacity (kW). Apply to Penticton average insolation to deliver average monthly output.
 - Hourly Shape: Apply hourly average distribution of solar output.
- **Storage:**
 - Load Requirements: Apply hourly average residential customer load to solar PV output. Identify average net load.
 - Specify Charge/Discharge Algorithm: TBC in discussion with FortisBC. Initial specification: charging during hours of excess PV production, discharging as required in evening as PV production wanes. Possible alternative: utility partial control – in winter months discharge maximum at time of system peak, remainder discharged as required by user in hours that follow.
 - Storage Parameters: Assume Tesla Powerwall useable storage volume (13.5 kWh), charging/discharging capability (7 kW peak / 5 kW continuous), and efficiency (90%). TBD: number of Powerwalls (1 or 2) per home.

Data Sources

Data Element	Potential Source
Avg. PV nameplate capacity per home: 4 kW (1 kW = ~7.5 m ² of area)	IESO: Long Term Energy Plan or FortisBC Historical Data.
Monthly insolation (kWh/m ²) solar energy potential - Penticton	NRCan: Photovoltaic Potential and Solar Resource Maps of Canada
Hourly distribution of solar output - Penticton	NREL's PVWatts Calculator
Residential load requirements (avg. single-family hourly loads).	FortisBC Load Research Data
Energy storage parameters	Tesla

INTEGRATED PHOTOVOLTAIC SOLAR STORAGE SYSTEMS (IPSS) – NON-RESIDENTIAL >40KW



Description

The non-residential application of PV and storage combined. Storage and solar are used together minimize customers' average noncoincident peak demand. Unlike residential IPSS, storage may be charged overnight or in other off-peak times to allow customers to optimize output to average non-residential >40kW customer hourly demand profile. This driver will **decrease** load.

Characterisation Approach

- **Develop PV output profile:**
 - Monthly Output: Determine average business system capacity (kW). Apply to Penticton average insolation to deliver average monthly output.
 - Hourly Shape: Apply hourly average distribution of solar output.
- **Storage:**
 - Load Requirements: Apply hourly average commercial >40kW customer load to solar PV output. Identify average net load.
 - Specify Charge/Discharge Algorithm: To be confirmed in discussion with FortisBC. Initial specification: charging during hours lowest average demand, discharging during hours of highest demand (net of PV output). Purpose: to flatten load curve and avoid demand charges.
 - Storage Parameters: Assume Tesla Powerpack useable storage volume (210 kWh), charging/discharging capability (50 kW), and efficiency (88%). TBD: number of Powerpacks per business (since averages being used, may be a fractional number).

Data Sources

Data Element	Potential Source
Avg. PV nameplate capacity per business: TBD	Average Nameplate Capacity Of Appropriate Ontario's Feed-in Tariff (FIT) Contract Offers .
Monthly insolation (kWh/m ²) solar energy potential - Penticton	NRCan: Photovoltaic Potential and Solar Resource Maps of Canada
Hourly distribution of solar output - Penticton	NREL's PVWatts Calculator
Commercial > 40kW hourly load requirements	FortisBC Load Research Data
Energy storage parameters	Tesla

ELECTRIC VEHICLES (EV)



Description

Electric vehicles can be used for both personal and business purposes. Light duty include plug-in hybrids (PHEV) and battery electric (BEV) vehicles, both personal and fleet (commercial). Medium and heavy duty vehicles include return-to-base fleet vehicles, busses, and combination tractors. This load driver is likely to **increase** load.

Characterisation Approach

- **Determine energy impacts**
 - **Average annual consumption by light duty vehicle (LDV) type:**
 - PHEV (plug-in hybrid electric vehicle)
 - BEV (battery electric vehicle)
 - **Average annual consumption by medium and heavy duty vehicle (MHDV) type:**
 - Return to base fleet
 - Busses
 - Combination Tractor (CT)
- **Determine peak impacts using charging profiles (may change by scenario)**
 - **LDV by place charged:** 63% home charging, 19% workplace charging, 18% other public
 - **LDV and MHDV by charger level:** % level 1 (capacity: 1.44 kW), % level 2 (capacity: 6.6 kW), % DC fast charging (capacity: 50 kW)

Data Sources

Data Element	Potential Source
Distribution of charging places	Simon Fraser University: Electrifying Vehicle
Charger capacity	National Research Council: Overcoming Barriers to Electric Vehicle Deployment
Average annual consumption by type of vehicle	CPR
Charging profiles	CPR, Other Potential Studies, Public Source on Commercial Vehicles , Public Source on Buses

FUEL SWITCHING, GAS-TO-ELECTRIC (FS G2E)



Description

Electricity has the potential to replace current fossil fuel use in homes, with customers making a switch from gas to electric. This is done through the electrification of residential space- and water-heating. Natural gas forced air systems are replaced with efficient electric systems, based on the average mix of equipment types the adoption of which is projected in the Technical Potential of the CPR. This load driver is likely to **increase** load.

Characterisation Approach

- Assume that the natural gas equipment is being replaced by a representative mix of equipment as modelled in the CPR fuel switching analysis
- Use the total Technical Potential for appropriate end-uses from the fuel switching analysis in the CPR and divide by installed stock to calculate unit impacts
- Navigant will use annual hourly load profiles for electric space and water heating to determine impact of G2E fuel switching in peak demand

Data Sources

Data Element	Potential Source
Electricity consumption, efficiencies, and total stock for space-heating and water-heating	CPR
Estimated unit energy consumption of primary and secondary electric space-heating equipment, and of water heating equipment	FortisBC: Residential End-Use Study 2018 (to be provided) or 2014 CPR data
Peak Demand Impacts	CPR or FortisBC Provided Data

FUEL SWITCHING, ELECTRIC-TO-GAS (FS E2G)

Description

The replacement of electric residential space- and water- heating with standard efficiency (i.e., code-compliant) natural gas fired equipment. Assume this applies only to standard efficiency (baseline) electric equipment; i.e., electric heat pumps or heat pump water heaters are not replaced by gas-fired equipment. This load driver will **decrease** load.

Characterisation Approach

- Obtain heating energy consumption per household from CPR
- Compare the efficiency of gas and electric space-heating equipment in British Columbia using data from measure characterizations in the CPR
- Hourly space- and water-heating demand impacts will be used to determine peak impacts
- Assume only customers with non-heat pump electric space-heating equipment would elect to switch space-heating fuel (TBC)

Data Sources

Data Element	Potential Source
Electricity consumption, efficiencies, and total stock for space-heating and water-heating	CPR
Distribution of heat pump and non-heat pump equipment in FortisBC territory	FortisBC
Peak Demand Impacts	CPR or FortisBC provided data

CLIMATE CHANGE (CC)



Description

The increasing average annual temperatures as a result of global climate change will increase loads in the summer (air conditioning), but decrease loads in the winter (space heating). This load driver will **decrease** load.

Characterisation Approach

- This load driver will be characterized in the same manner it was done in 2016 with two key updates:
 - Updating the US government monthly temperature forecast (if it has changed)
 - Parameters used in FortisBC's base forecast
- Analyze the impact of this load driver by aggregating it according to heating degree days (HDD) and cooling degree days (CDD) instead of 'unit' form. No peak impacts.
- The change in average monthly temperature forecast for Grant and Benton counties in Washington State for the 2030-2039 period
- Historic average monthly temperature for Penticton, B.C. and Summerland, B.C.
- Average HDD and CDD for the FortisBC area used in FortisBC's base forecast
- Impact of each HDD and CDD on FortisBC electricity consumption (based on estimated weather sensitivity parameters provided by FBC)

Data Sources

Data Element	Potential Source
Average HDD and CDD for FortisBC area	FortisBC Weather Values (to be provided)
Weather data	Environment Canada
Electricity consumption	FortisBC Consumption Data (to be provided)

LARGE LOAD SECTOR TRANSFORMATION



Description

Structural transformation of the large C&I sector, and a rapid increase in highly energy-intensive sub-sectors/segments in non-traditional industries. The sectors that will be analyzed are data centres and cannabis greenhouses. Relatively low energy prices and the legalization of commercial cannabis production suggest the possibility of significant growth in these segments. This load driver is likely to **increase** load.

Characterisation Approach

- Identify segments of customers in FortisBC territory with large loads unrelated to traditional large load customer industries (pulp and paper, manufacturing, etc.). These will include:
 - Data Centres
 - Cannabis Greenhouses
- Rounded average historically observed consumption level across all customers within each identified segment per square foot by segment
- Create hourly load profiles for both segments
- Combine consumption with load profiles to derive unit impacts

Data Sources

Data Element	Potential Source
Historical average consumption by segment	CPR, IESO APS, or FortisBC Consumption Data
Load profiles by segment	CPR, IESO APS, or FortisBC Consumption Data

HYDROGEN AND SYNTHETIC METHANE PRODUCTION (HSMP)

Description

Electricity consumption driven directly by the growth in the industrial sector related to the production of “green” hydrogen and synthetic methane (key ingredients for renewable gas). This load driver is likely to **increase** load.

Characterisation Approach

- Efficiency of electrolysis
 - Based on conversion efficiencies used in Navigant's Gas for Climate and Energy Vision 2050 engagements
 - These efficiencies will be benchmarked with other publications and use case examples from FortisBC electrolysis pilot projects in BC
- Electrolysis load profile
 - Assume that electrolysis load profile is the inverse of an average load profile, indicating that electrolysis is carried out in low demand times.
- Note that hydrogen production will be limited to 5% of the natural gas distribution throughput by volume, unless CCS is in place to upgrade to synthetic methane.

Data Sources

Data Element	Potential Source
Gas for Climate Models	Navigant (March 2019)
Energy Vision 2050 Models	Navigant (October 2019)
Conversion Efficiency - Alternate	IRENA - Hydrogen from Renewable Power, Technology Outlook for the Energy Transition (September 2018)

CARBON CAPTURE AND STORAGE (CCS)

Description

Electricity consumption is driven by the power requirements of CCS technologies used to capture carbon emissions from industrial processes. Blue hydrogen production is a large driver of CCS (i.e. through natural gas reformation). CCS can also be applied to many carbon-emitting industrial processes. Much of this captured carbon can be used to upgrade hydrogen to synthetic methane. This load driver is likely to **increase** load.

Characterisation Approach

- Navigant will assess unit electricity impacts using an assumed energy intensity of 0.3 kWh of electricity used capture 1 kg of CO₂.
 - This energy intensity is assumed to a standard assumption from public sources
 - Energy intensity of this process can range from 0.2 to 0.3 kWh/kg depending on the application. Navigant will determine if application-specific intensities will be require
- Peak impacts of CCS will follow the standard industrial load shape
 - It is assumed that carbon is captured as it is, so Navigant will use FortisBC – provided load shapes to determine peak demand impacts by hour and season
- The amount of CCS is highly dependent on the amount of hydrogen and synthetic methane produced, which varies by scenario

Data Sources

Data Element	Potential Source
Energy intensity of CCS	MIT Research Paper
	IEA CCS Paper
Industrial Load Shape	FortisBC

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NAVIGANT

Questions?

Demand-Side Management (DSM)

Steven Groves

Engineer, Conservation & Energy Management



Agenda

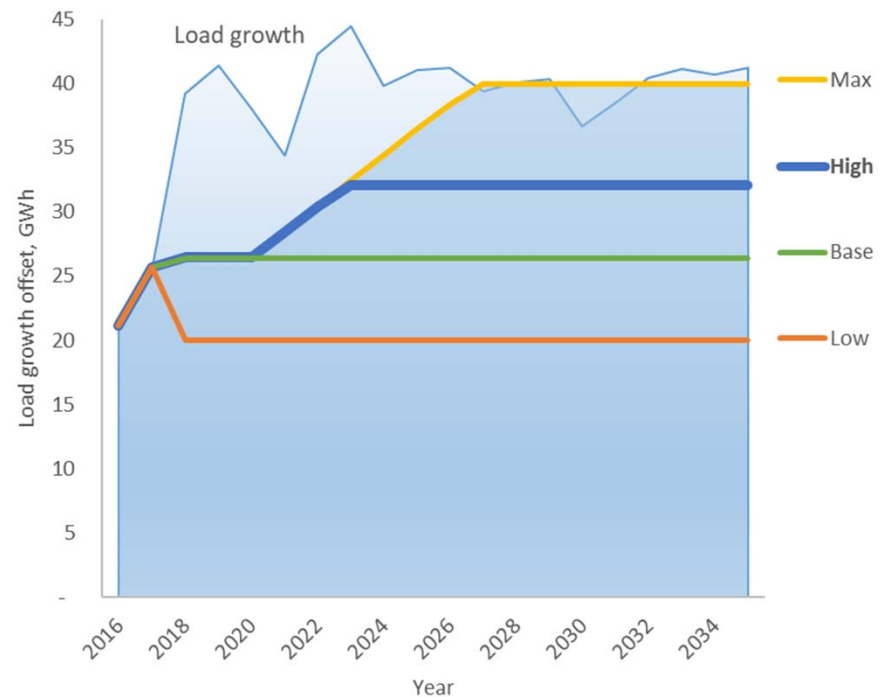
- DSM Definition
- Setting the long term DSM target
- DSM Planning
 - 2019-2022 Plan Updates
 - Demand response
- 2021 LT DSM Plan Roadmap

DSM Definition

- Clean Energy Act definition
 - **"demand-side measure"** means a rate, measure, action or program undertaken
 - a) to conserve energy or promote energy efficiency,
 - b) to reduce the energy demand a public utility must serve, or
 - c) to shift the use of energy to periods of lower demand,

Setting the long term DSM target

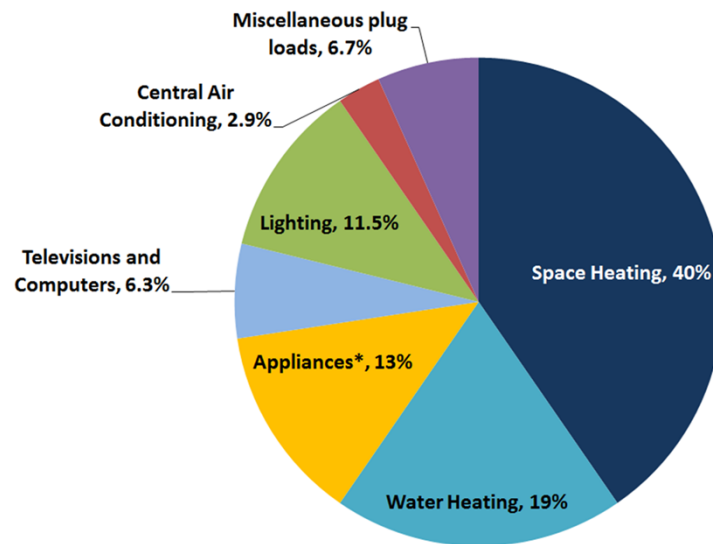
- DSM load growth offset (stated to apply to BC Hydro)
 - 2007 BC Energy Plan: 50 percent
 - Clean Energy Act: 66 percent
- FBC adopted
 - 50 percent in 2012 LTRP
 - 66 percent as Base Scenario in 2016 LT DSM Plan
 - 80 percent adopted in 2016 LT DSM Plan



Key End Uses

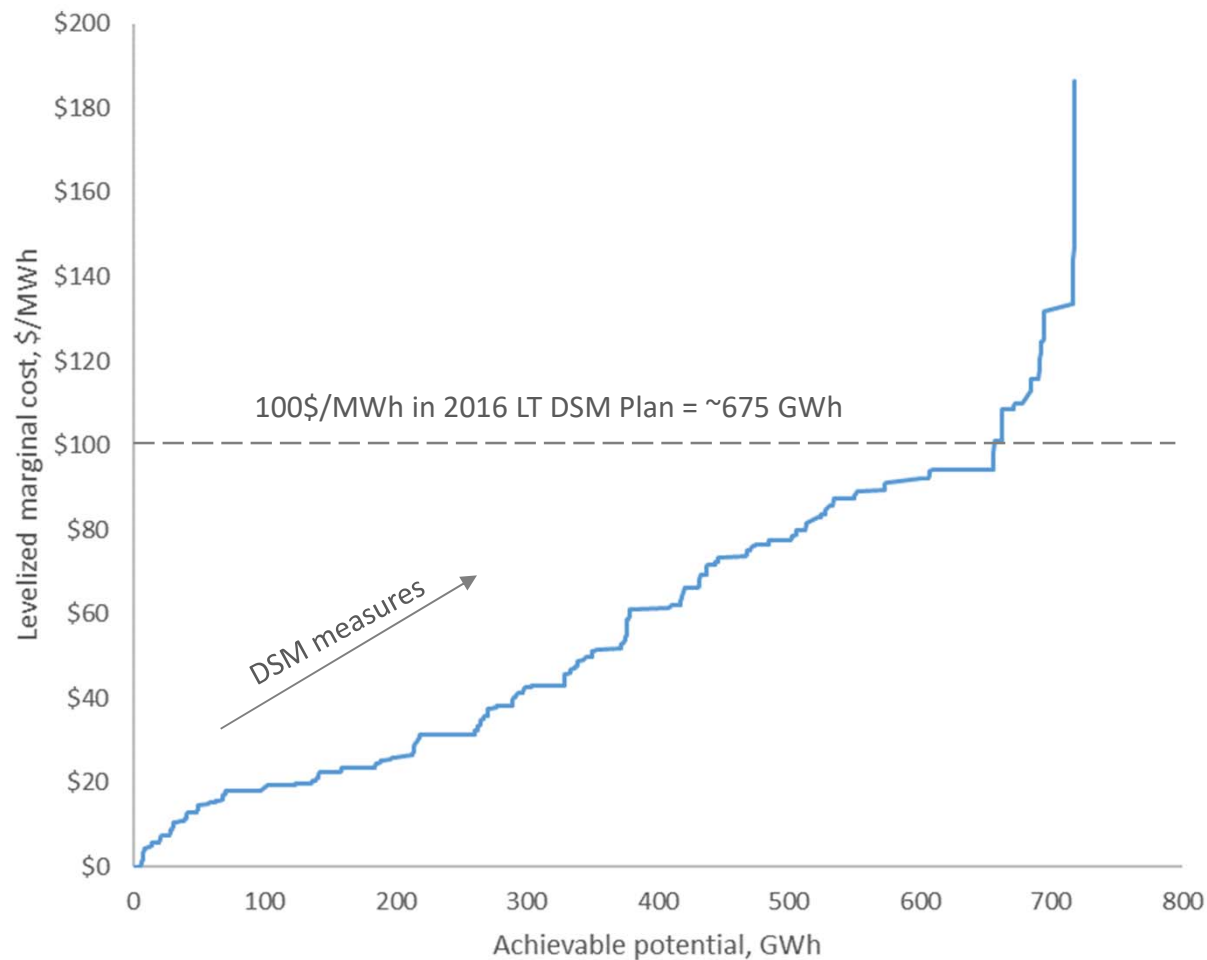
- Residential: envelope, space heating & cooling, water heating, lights, appliances.
- Commercial: envelope, HVAC, lighting, plug loads.
- Industrial: Lighting, compressed air, process.

Energy Consumption by End-Use in Single Family Dwellings

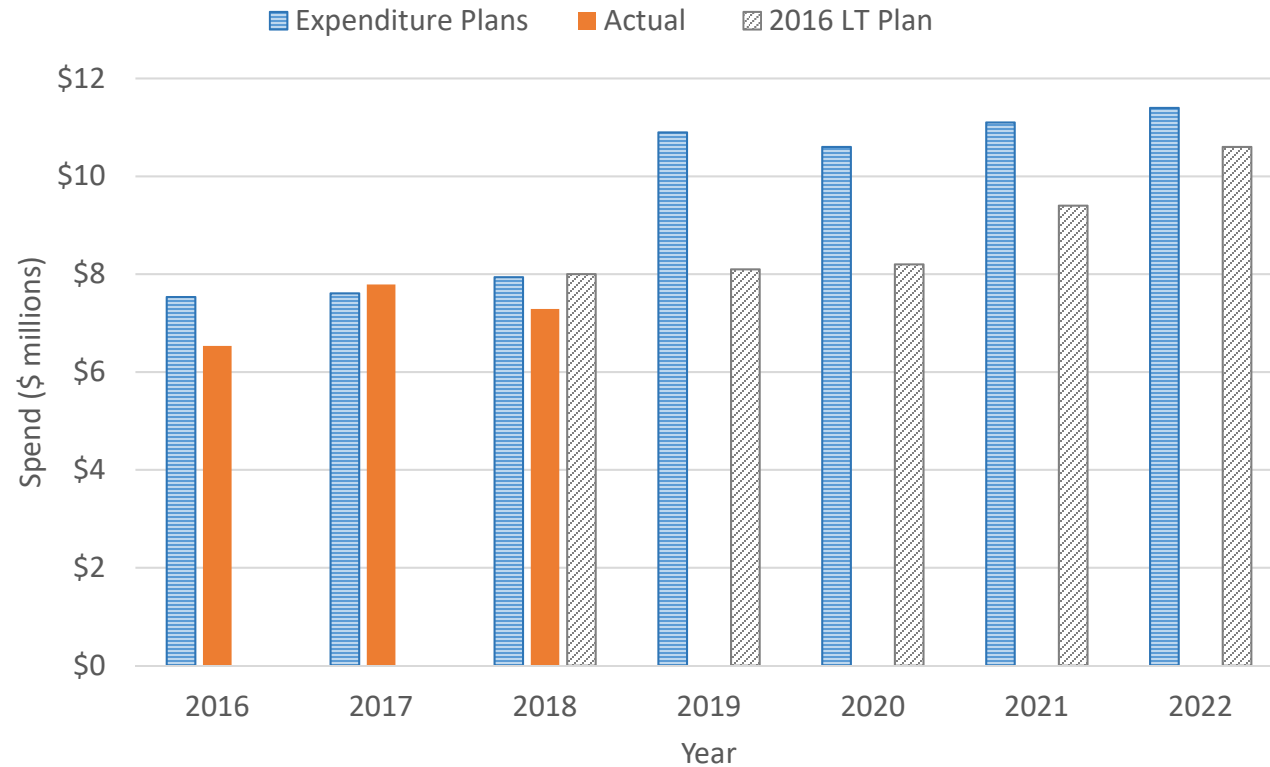


Cost Effectiveness

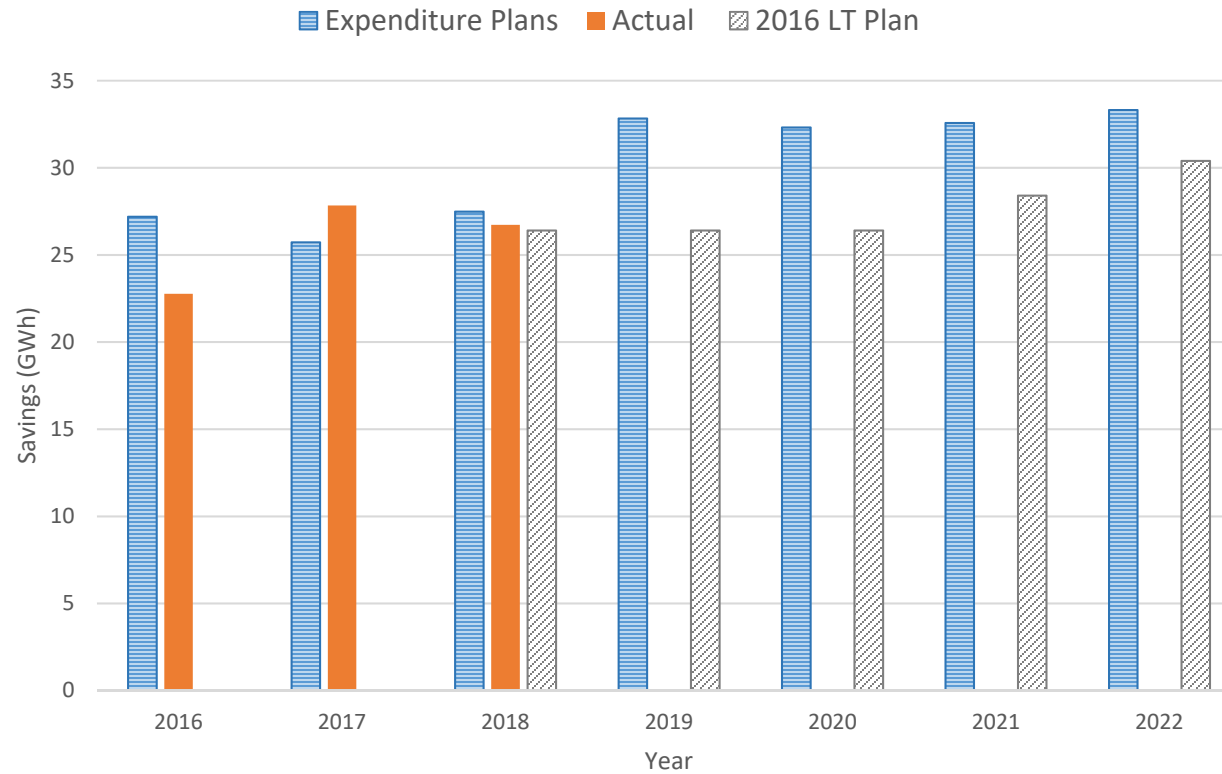
- Determined by Long Run Marginal Cost of BC “clean” or renewable resources



Expenditures: Plans vs. Actuals

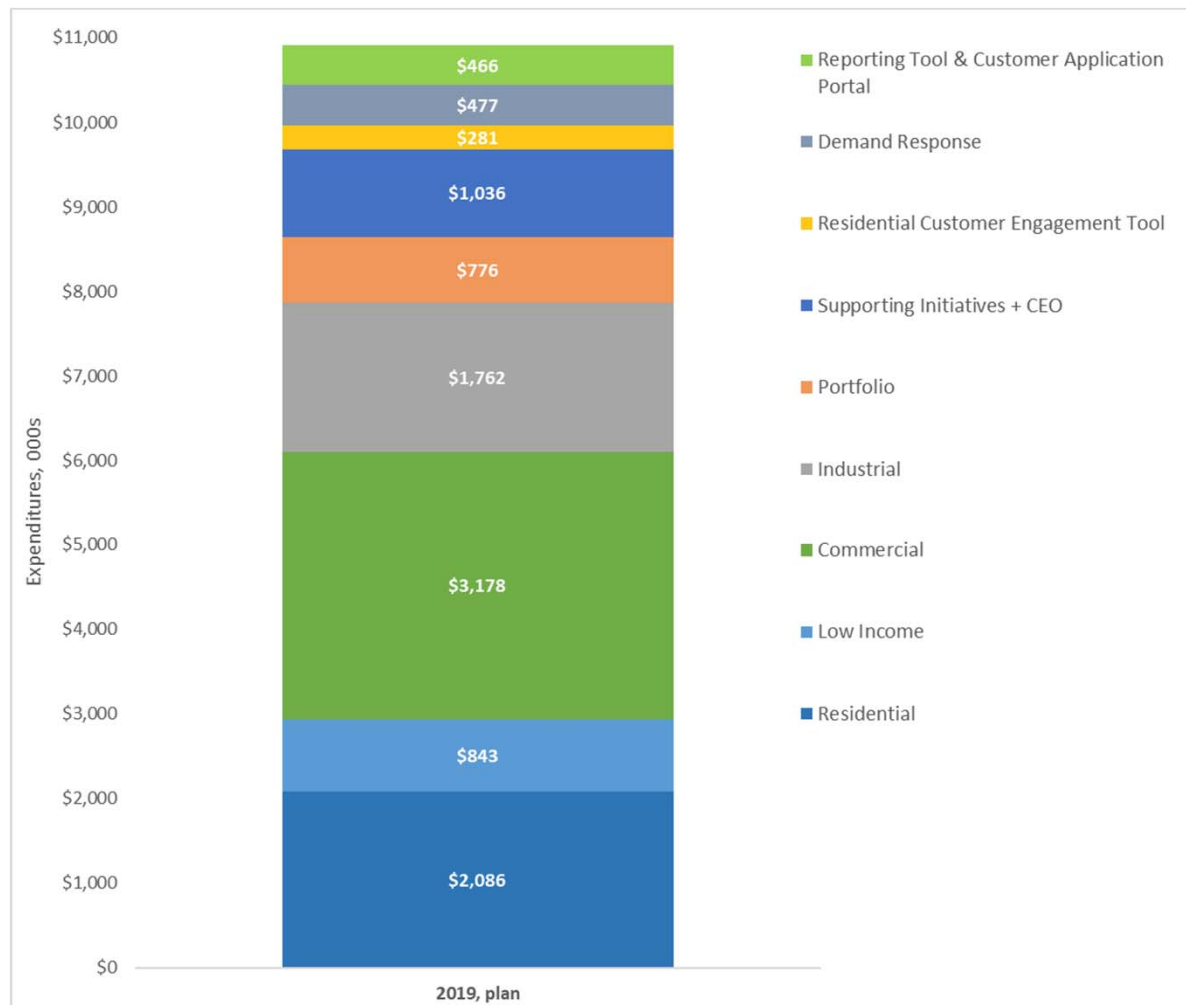


Savings: Plans vs. Actuals

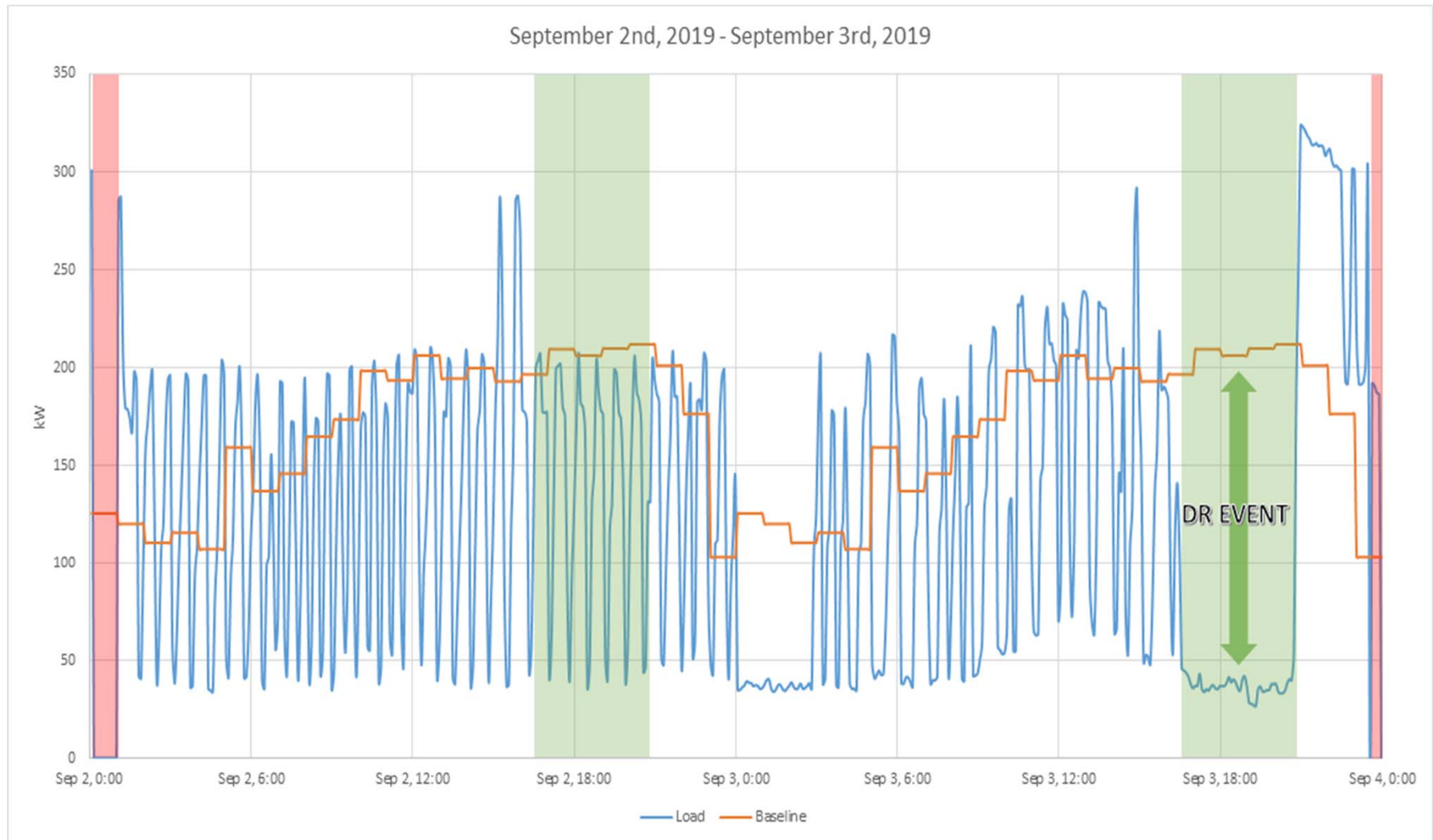


2019-2022 Plan Updates

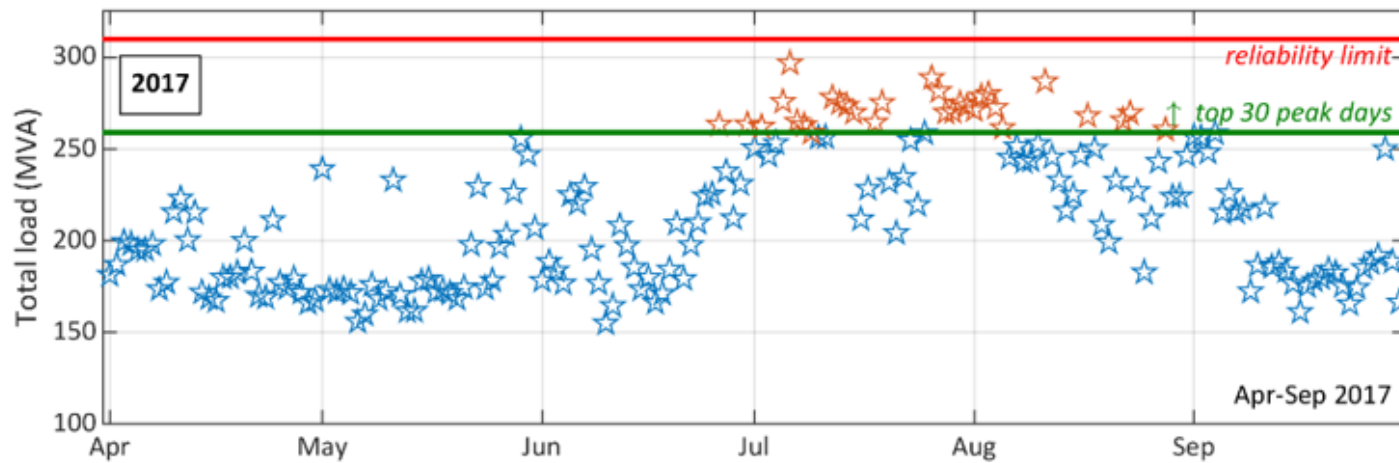
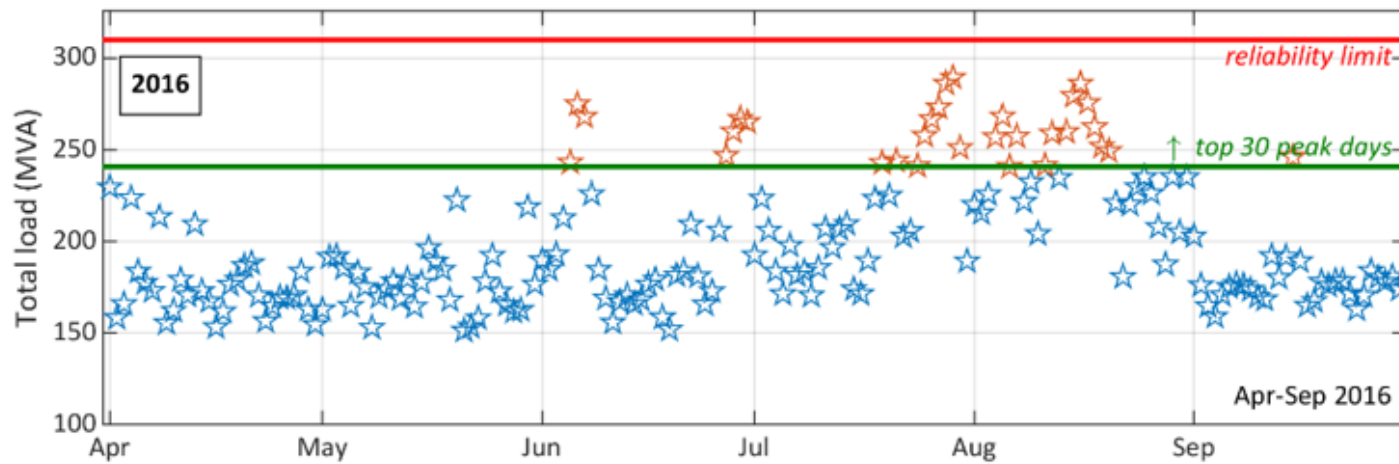
- Additional requirements for expenditure plans: low income, rental, education, codes & standards, innovative technologies.



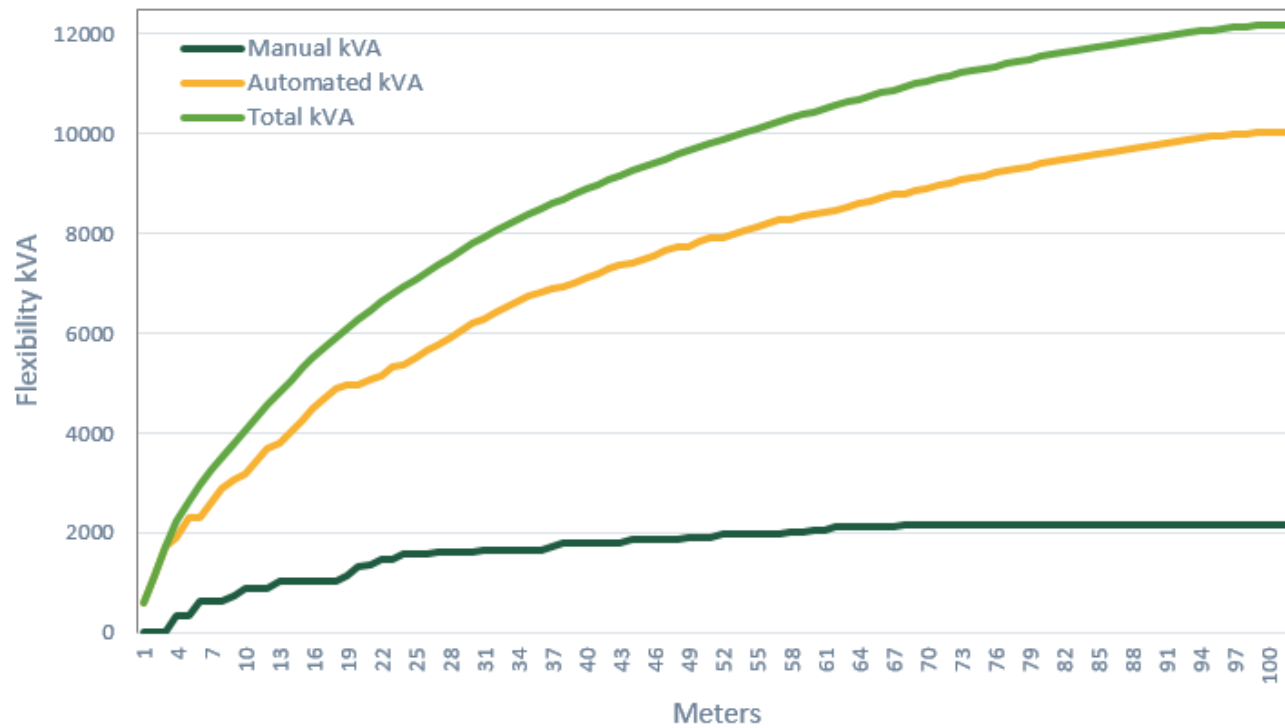
Demand Response Pilot



Daily Summer load peaks

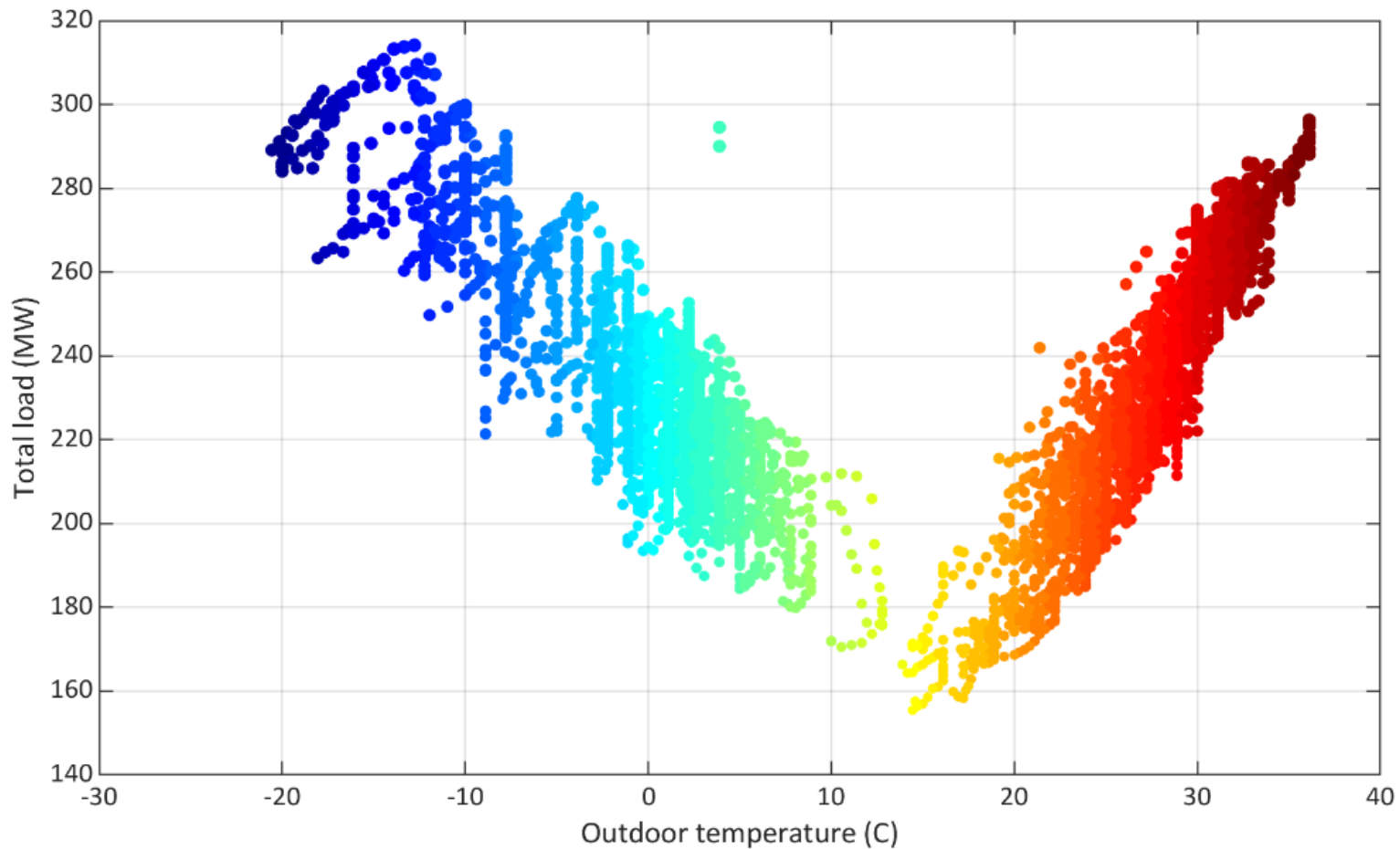


Potential Assessment



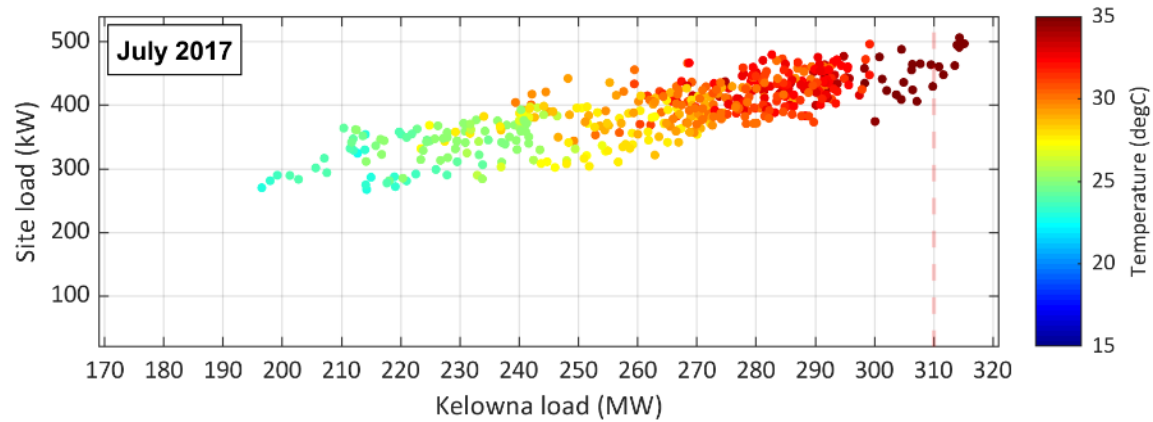
Kelowna Area Load Modelling

- Outdoor temperature is a primary driver of load

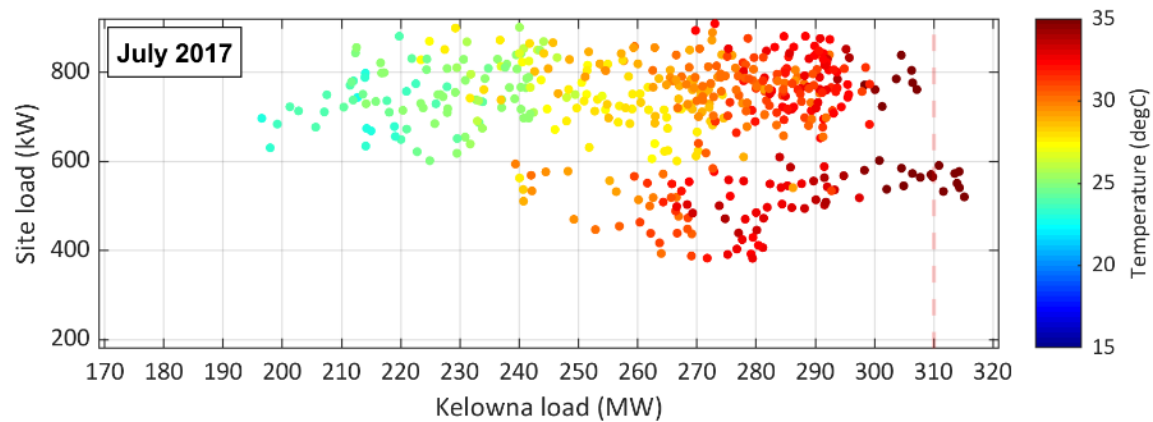


Demand Response Simulation

Health care customer



Industrial customer

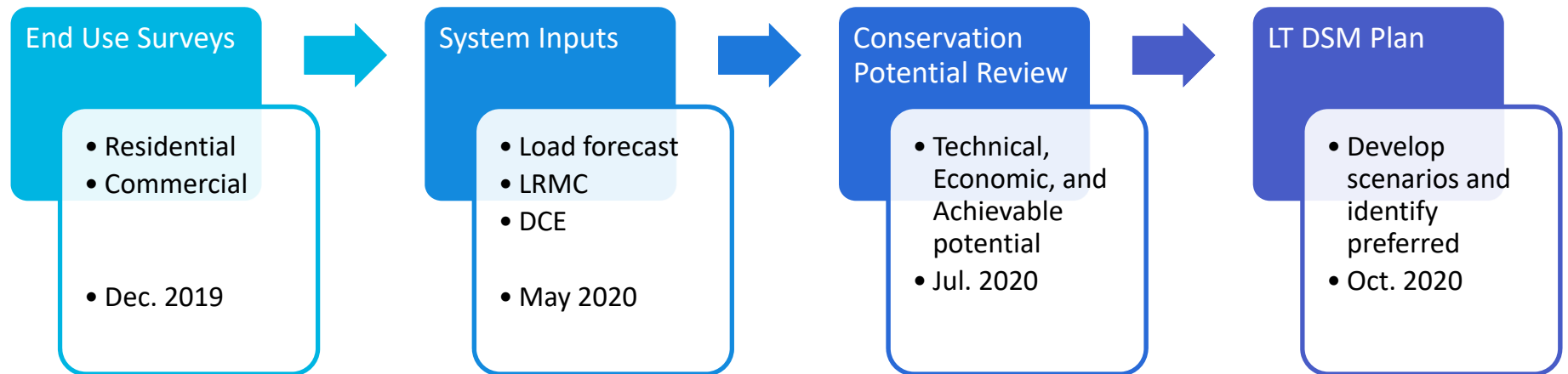


Pilot Results

- Program objective: enroll up to 24 customer to achieve 1.75 MW demand reduction when called
- 3 participants across 4 events: municipal, health care, institutional
- Achieved an average reduction of 45 kW reduction in 3 out of 4 events, ~8% of objective.
- Currently recruiting for Winter period and Summer 2020.

2021 LT DSM Plan Roadmap

- BCUC accepted 2016 LT DSM Plan and preferred scenario
- Key inputs to be updated:



End Use Surveys

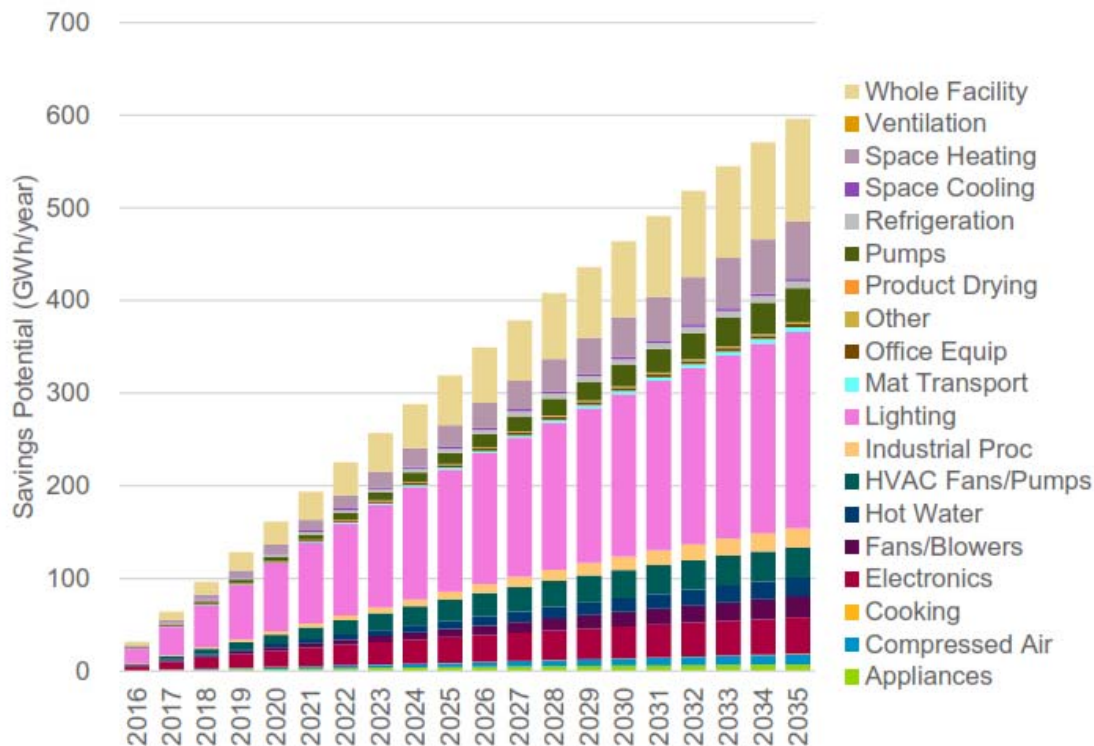
- 2017 Residential - complete

End-Use	Sample Size (unweighted)	Penetration (% presence)	Unit Energy Cons. (kWh/year)	Avg. per Household (kWh/year)
Primary Space Heating	534	41%	4,749	1,934
Electric and Plug-in Hybrid Cars	10	1%	3,178*	24.2*
Pools	9	<1%	2,919*	14.4*
Water Heating	678	41%	2,874	1,187
Hot Tubs	167	9%	2,818	265
Baseload	1,563	100%	1,736	1,736
Well Pumps	223	13%	1,734	232
Secondary Space Heating	438	25%	1,427	361
Lighting	1,563	100%	1,103	1,103
Home Entertainment Equipment	1,489	95%	1,001	949
Household Consumption				
Estimated				10,500
Actual				10,304

- 2019 Commercial - forthcoming

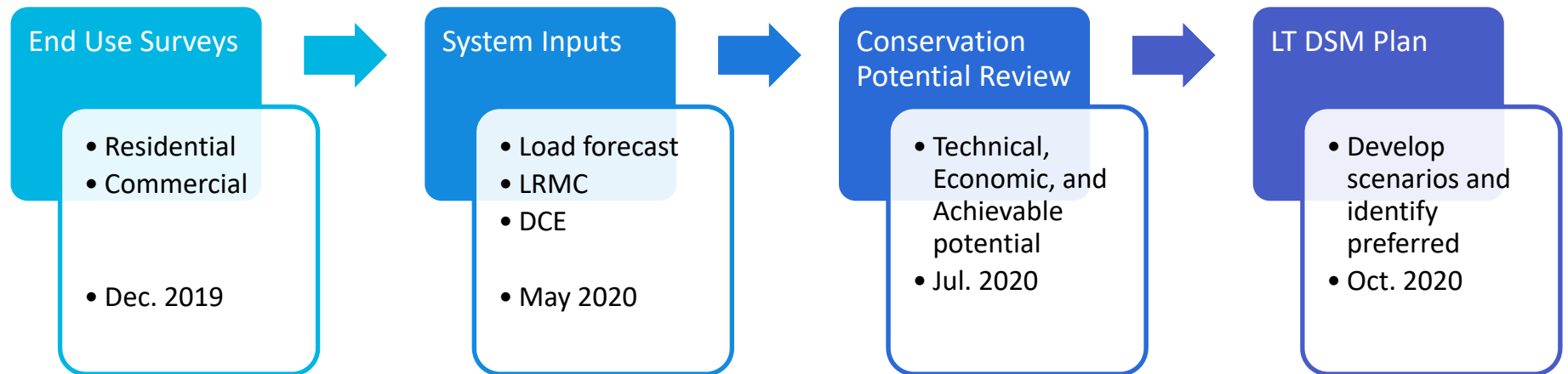
Conservation Potential Review Update

- End-use “stock & flow” model
 - Calibrated to match load forecast
 - Technical, Economic, and Achievable potential



Source: Navigant

Questions?



FBC Operations, Supply Resources, and Power Markets

Shannon Price

Power Supply Operations Manager

Agenda

- Introduction
- FBC Service Territory/Load
- FBC Resources and Market Power
- Characteristics of PNW Market
- Resource Options, Considerations, Feedback

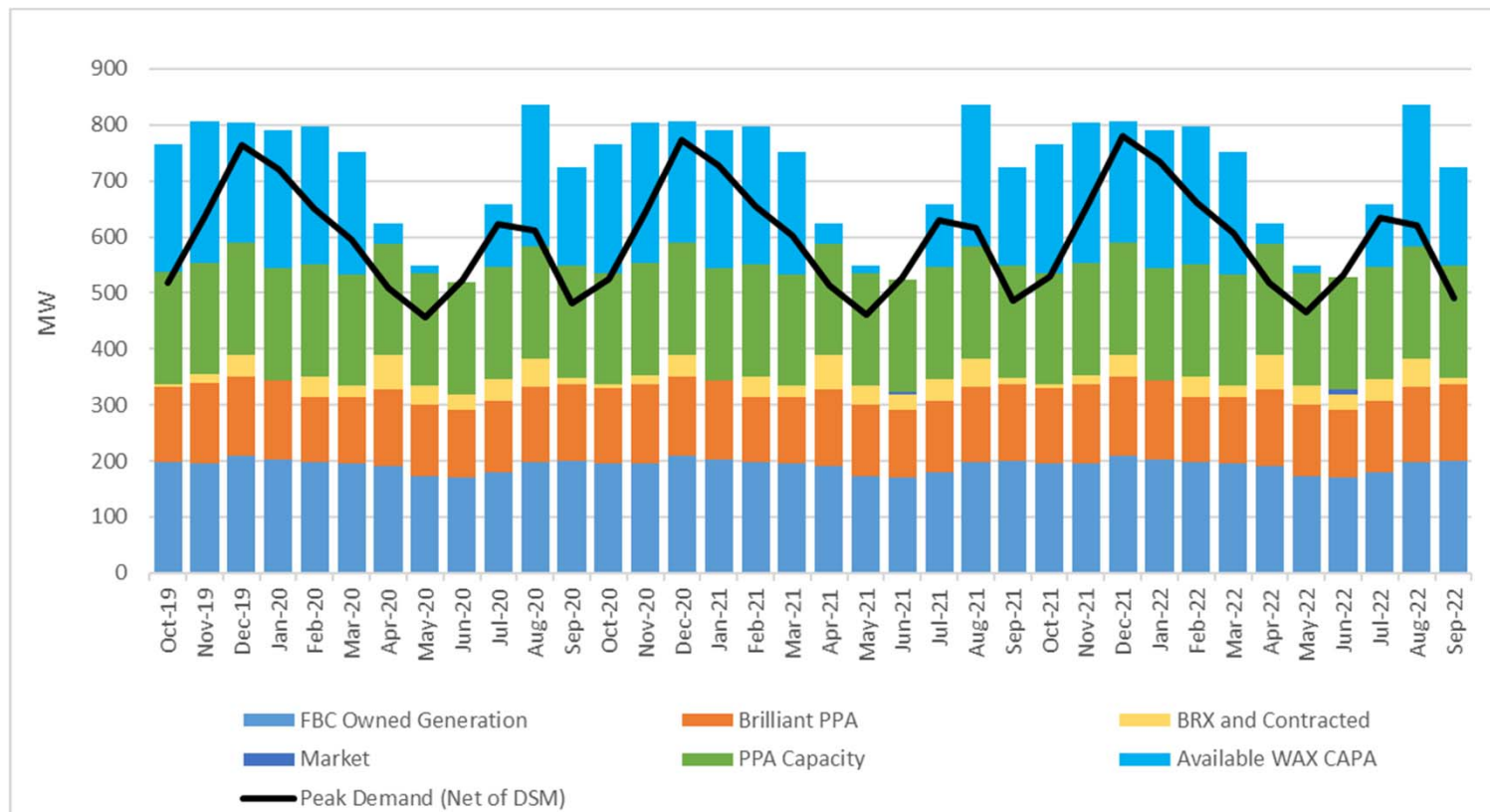
Introduction

The Role of Power Supply

- Starts with Load Forecast - Energy and Capacity
- Plan Resources to Serve Load - Generation and Transmission
- Long Term vs Short Term

Introduction

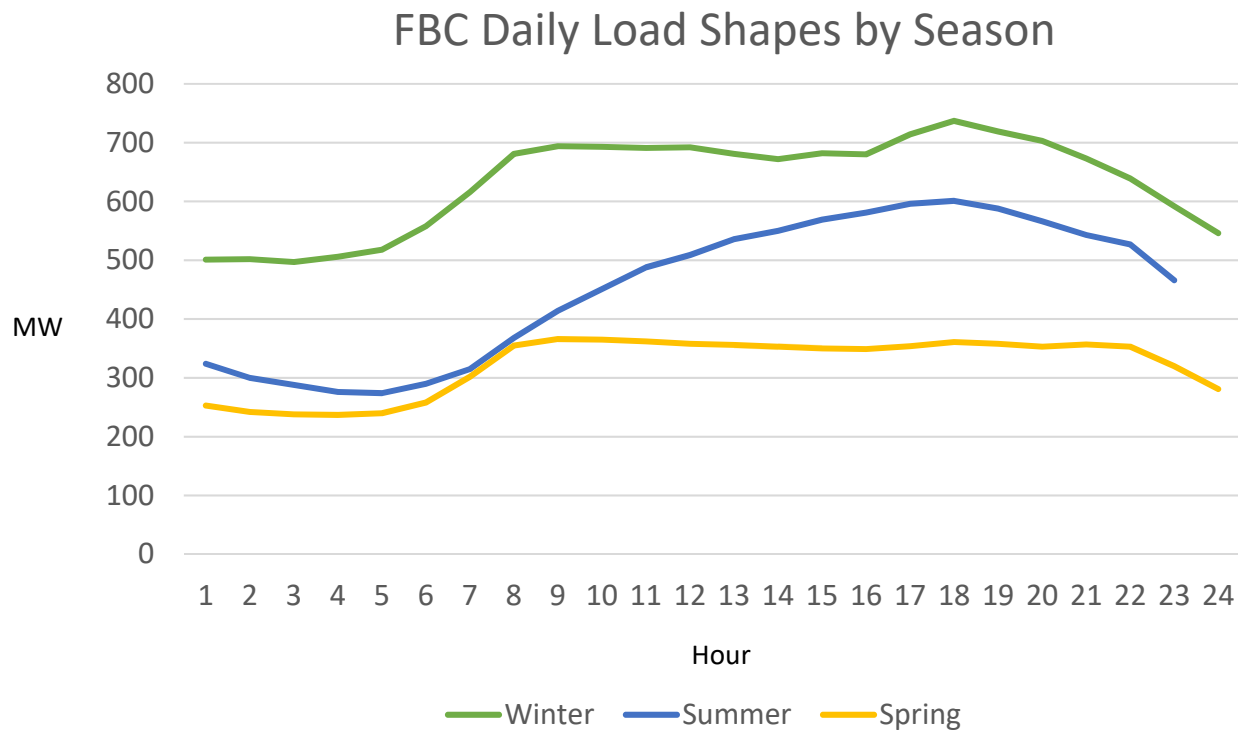
- Long term planning is less precise than short term planning
- Long term demand forecasting is driven by factors such as economic growth and population
- FBC is a winter peaking utility, but we also have a summer peak in July



Introduction

Actual demand for power changes constantly:

- Time of year
- Time of day
- Day of week
- Moment to moment



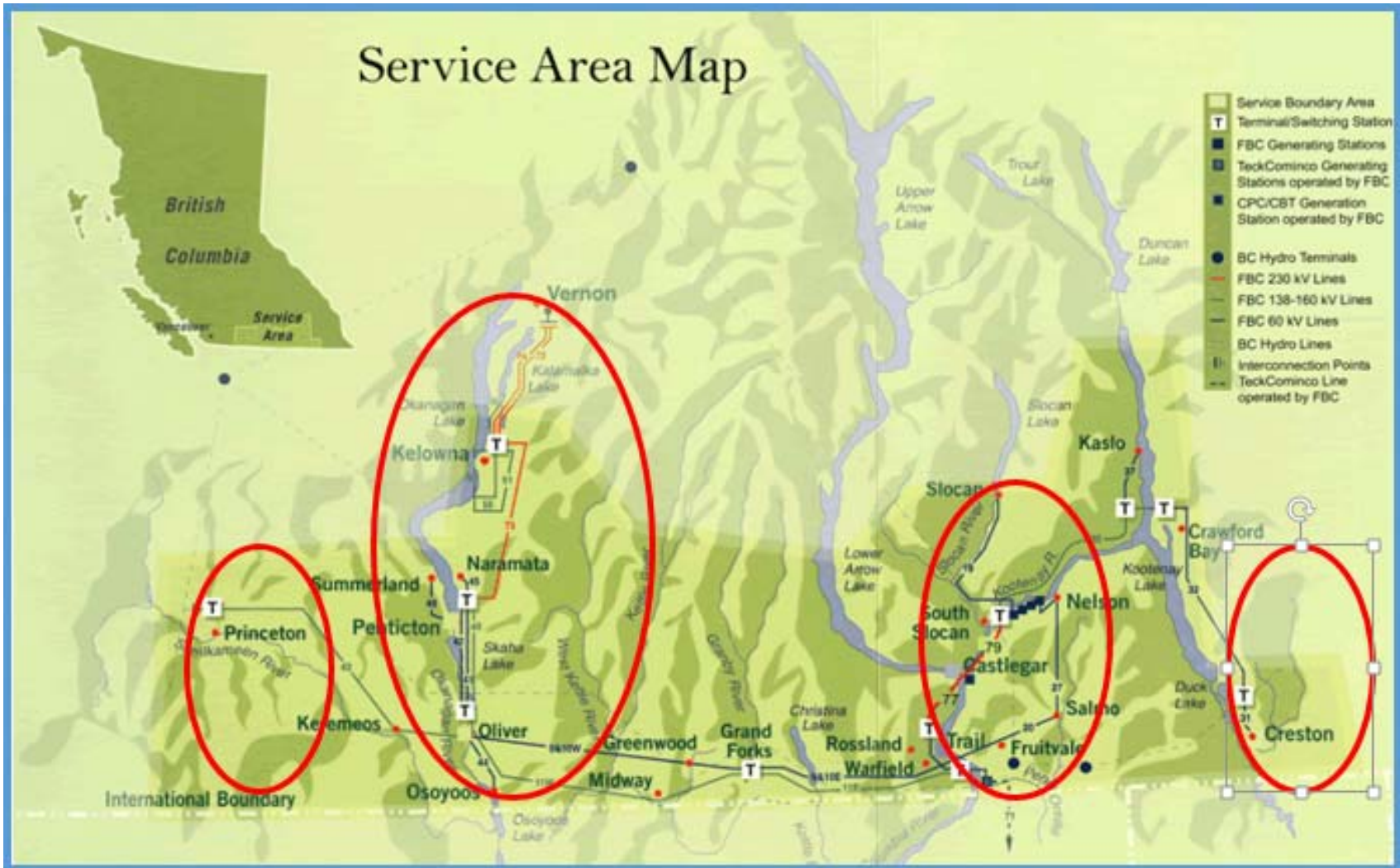
Introduction

- Generation

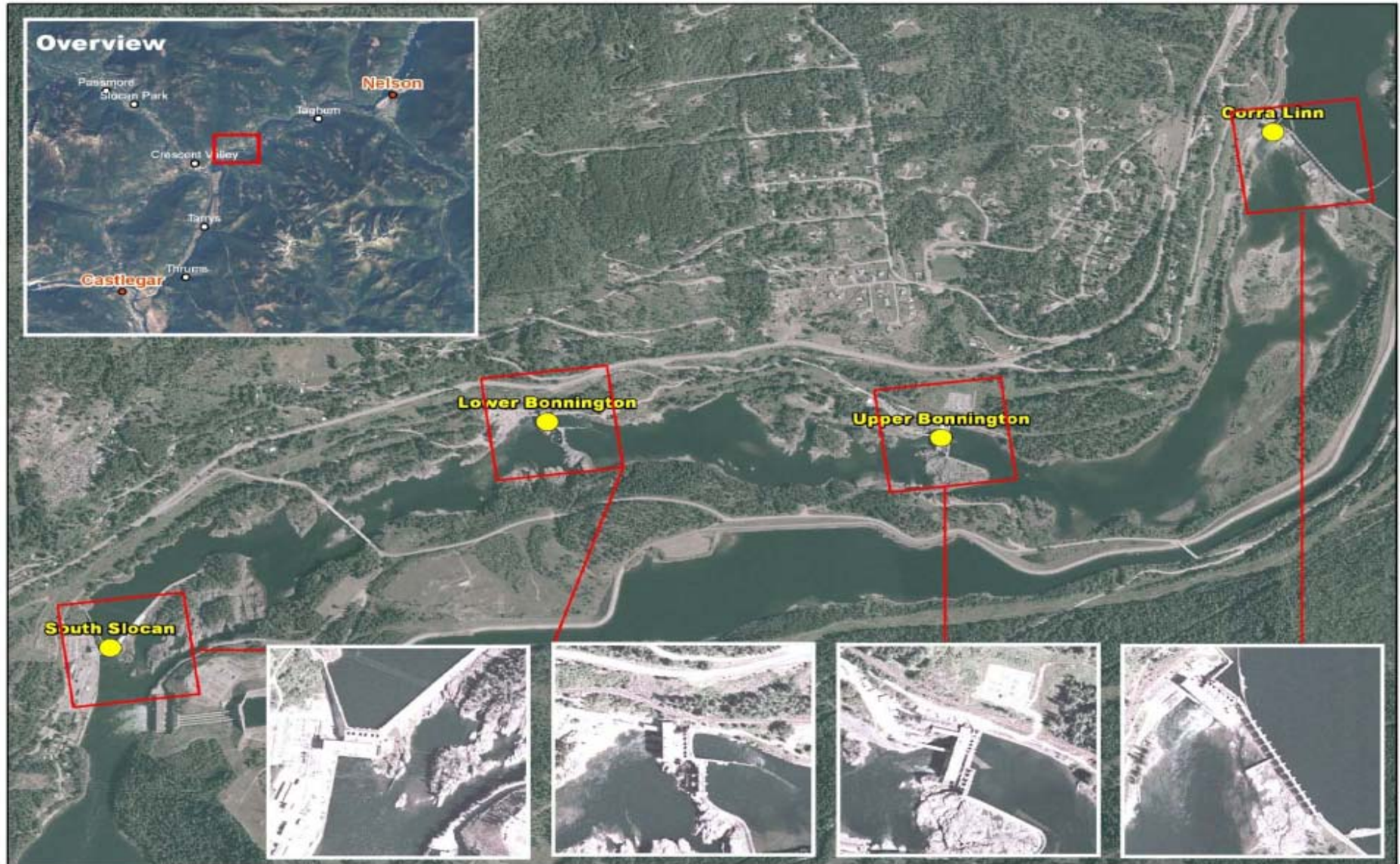
- Lots of ways to produce electrical power
- Different technologies have different costs
- Plants are dispatched when it's economical
- Once power is generated it must be brought to the customer
- In each hour of the day, there must be sufficient generation and transmission to meet customer demand



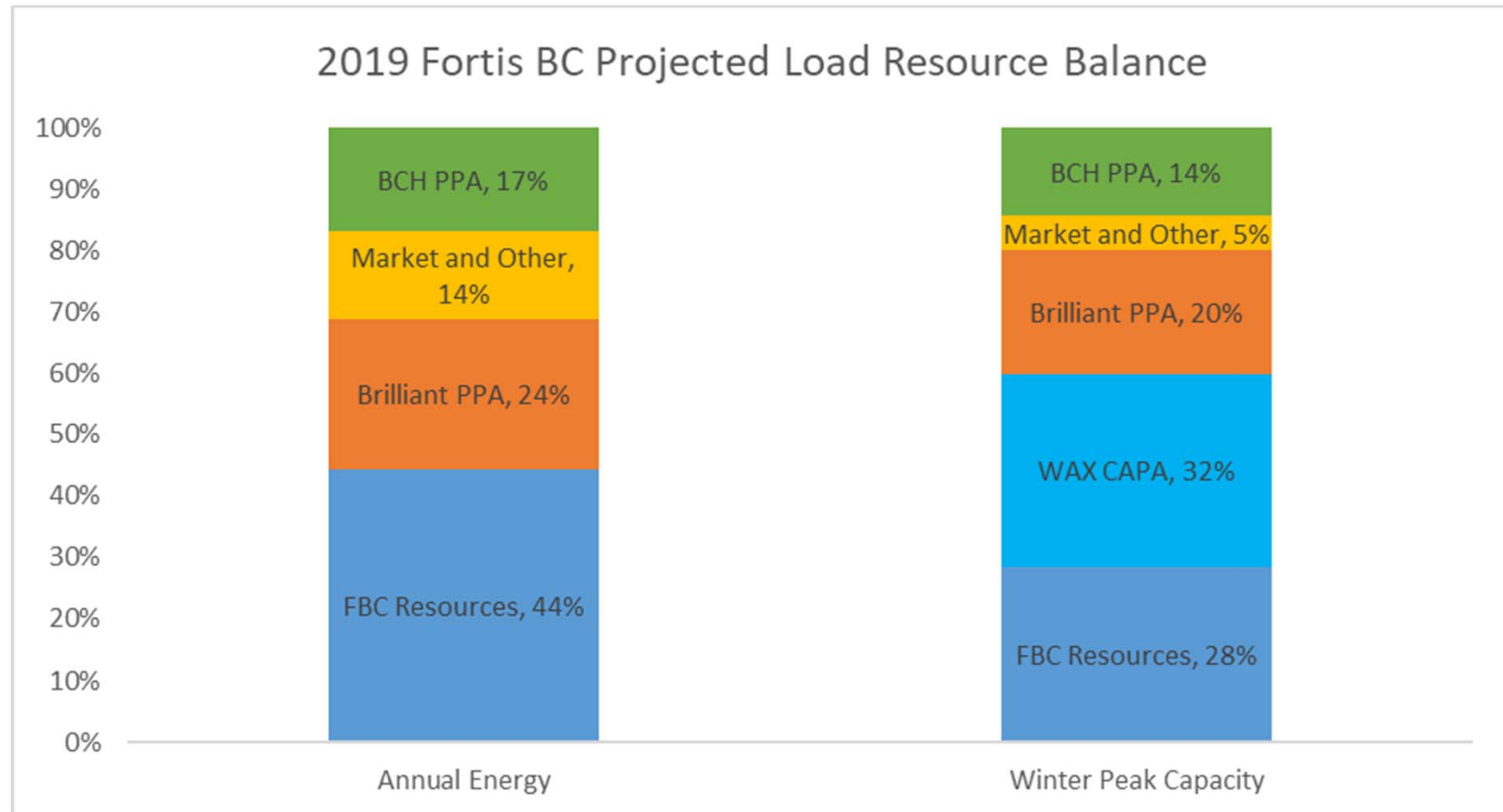
FBC Service Territory/Load



FBC Resources: Generation

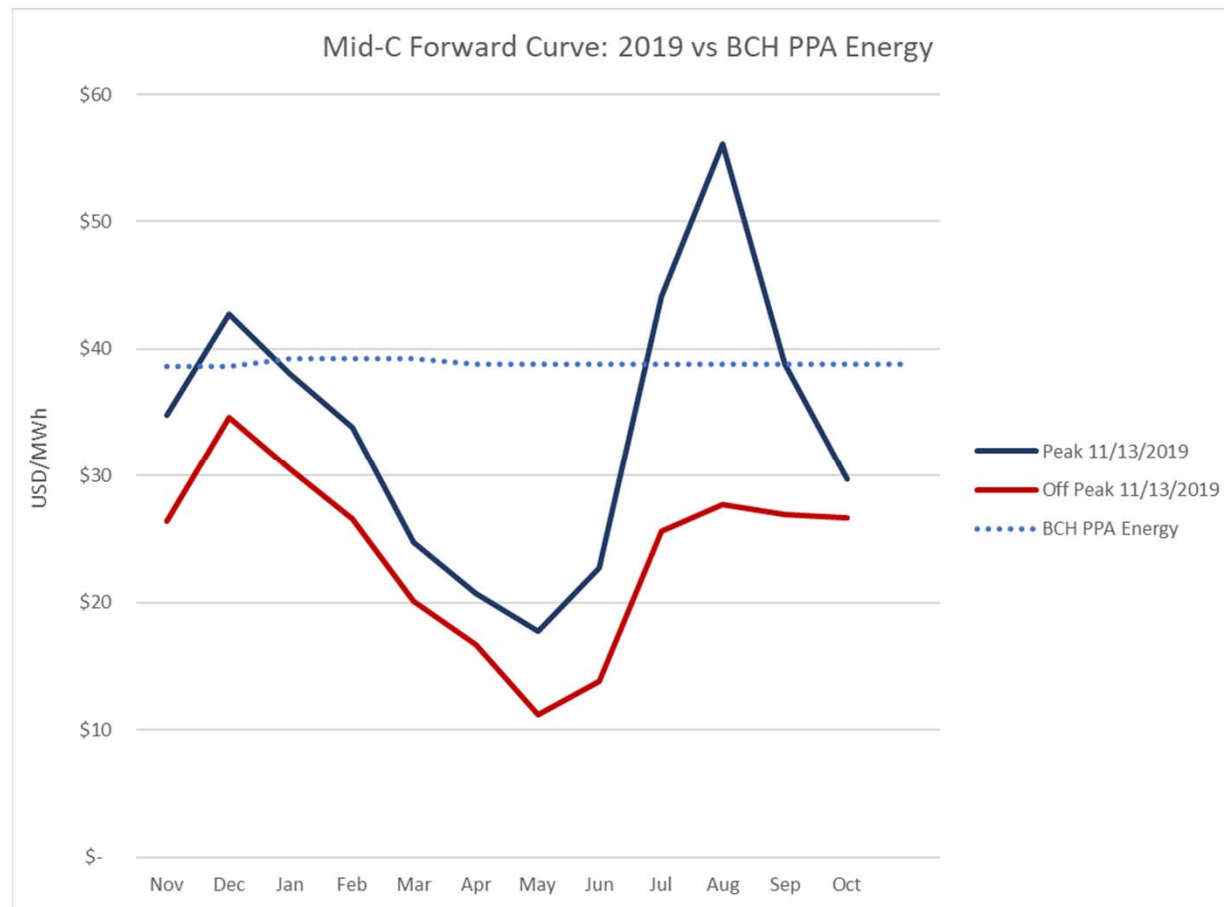


FBC Resources: Long Term Contracts



FBC Resources: Optimization of Market and PPA

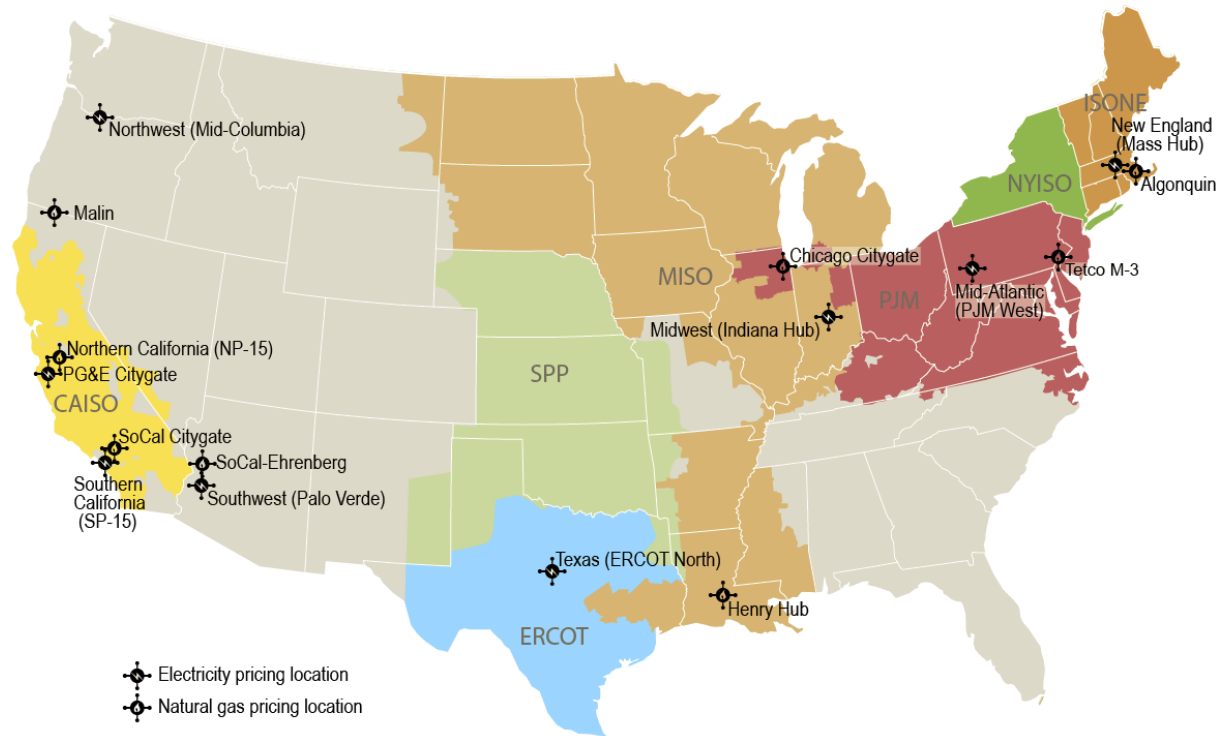
- FBC must make decisions both on a planning basis and in real-time



FBC Resources: Market Power

- FBC purchases power from the wholesale market
- Electricity is a physical commodity
- Competitive wholesale markets: prices reflect supply and demand

Selected price hub locations for wholesale electricity and natural gas reported by Intercontinental Exchange



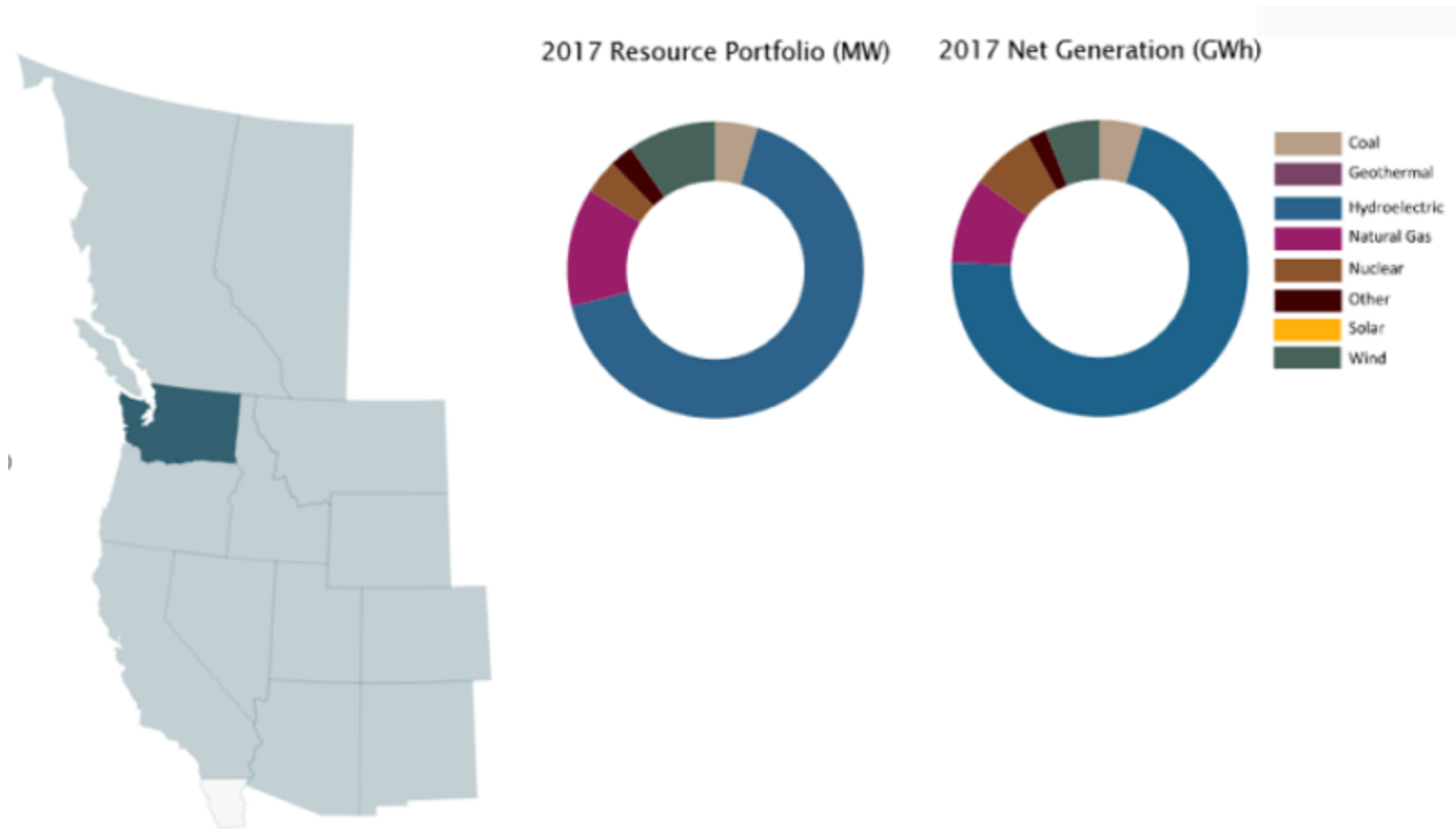
Note: Colored areas denote Regional Transmission Organizations (RTO)/Independent System Operators (ISO)
Source: U.S. Energy Information Administration based on Ventyx Energy Velocity Suite

FBC Resources: Market Power Uses

- Long term planning tool
- Short term balancing tool



Pacific Northwest Power Markets



<https://www.wecc.org/epubs/StateOfTheInterconnection/Pages/States-and-Provinces.aspx>

Market Access

- FBC has market access via 71L, rights could expire as early as 2037
- FBC is assuming that we will have something with similar access after expiration
- FBC is researching the option of sourcing all market purchases from green or clean sources

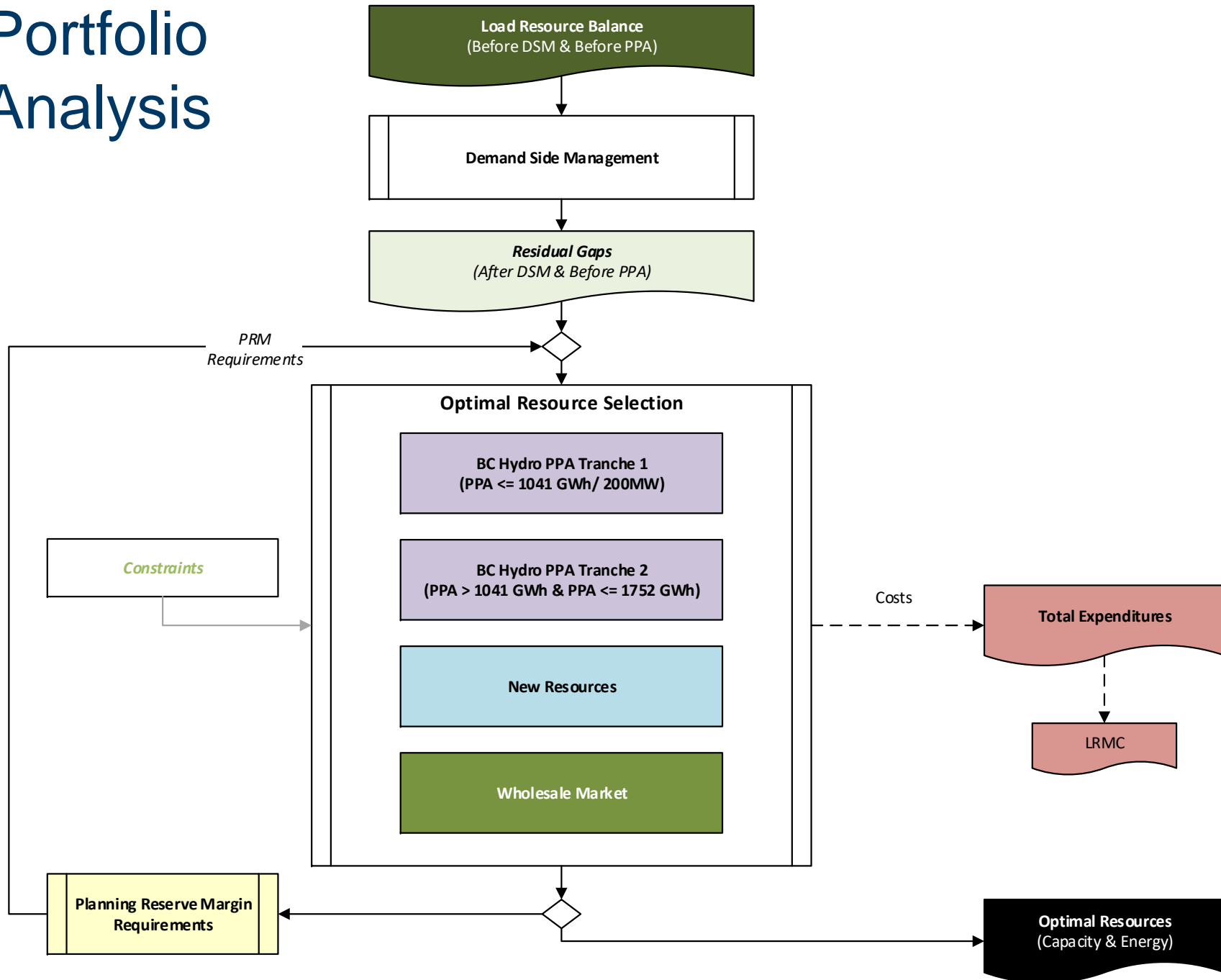
Questions?

Load-Resource Balance, Resource Options & Portfolio Analysis

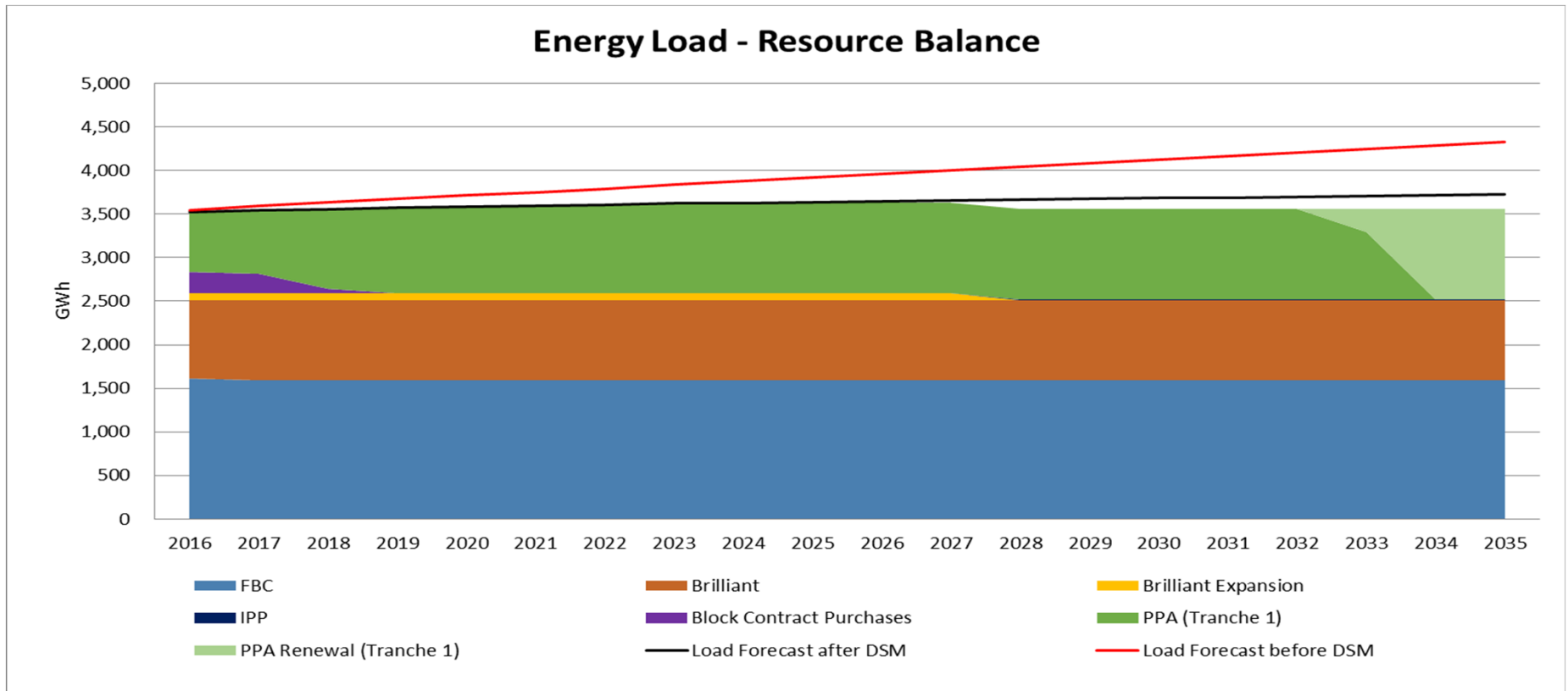
Mike Hopkins

Senior Manager, Price Risk & Resource Planning

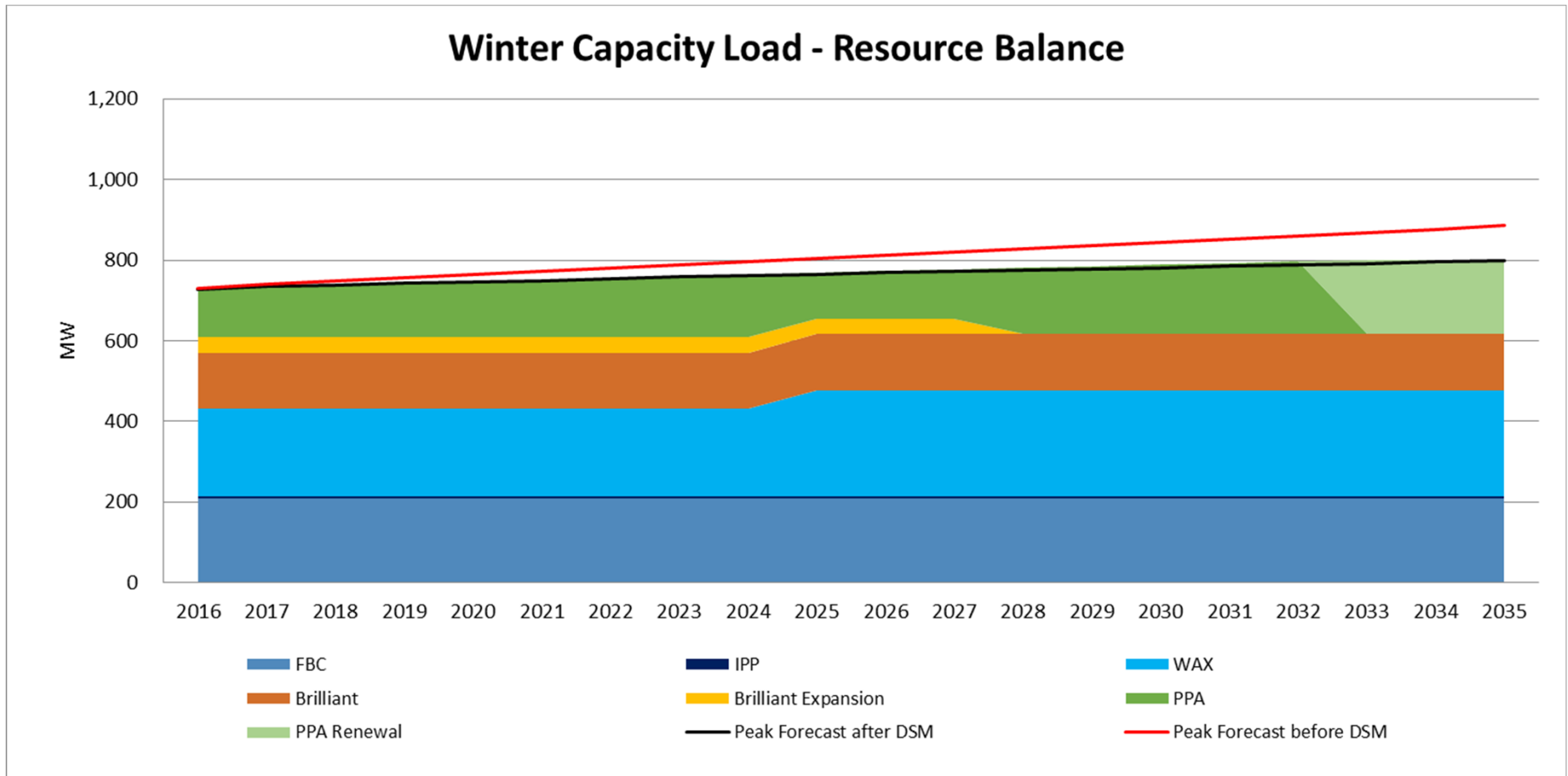
Portfolio Analysis



2016 LTERP Load-Resource Balance



2016 LTERP Load-Resource Balance



Supply-Side Resource Options



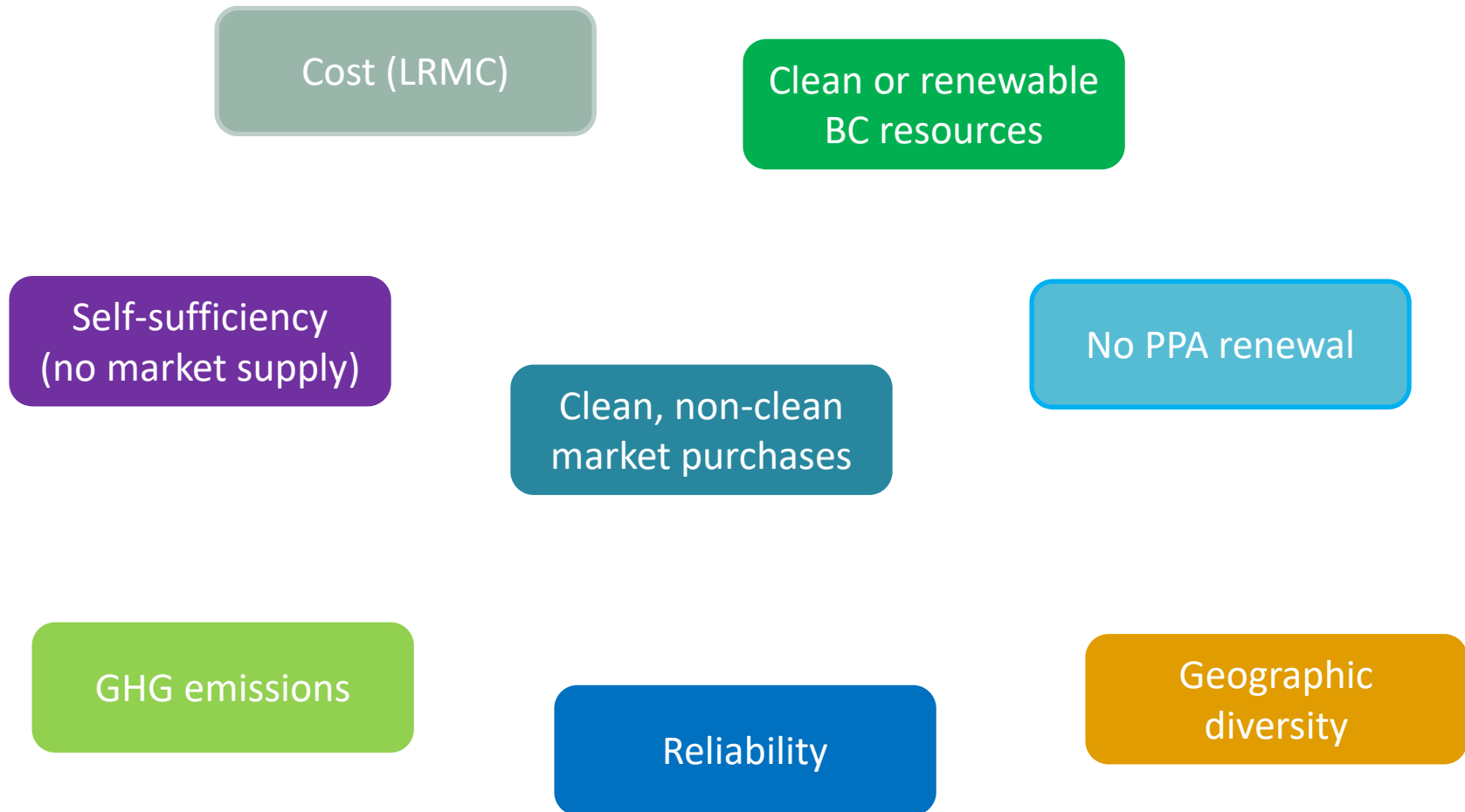
PPA

Market
Purchases

Portfolio Analysis

- What is the optimal mix of resources?
- Evaluation metrics should relate to planning objectives:
 - Ensure cost-effective, secure and reliable power for customers
 - Provide cost-effective demand-side management and cleaner customer solutions
 - Consistency with provincial energy objectives (e.g. applicable *Clean Energy Act* objectives, CleanBC plan)
- LRMC is an outcome, does not represent resource cost threshold

Portfolio Attributes

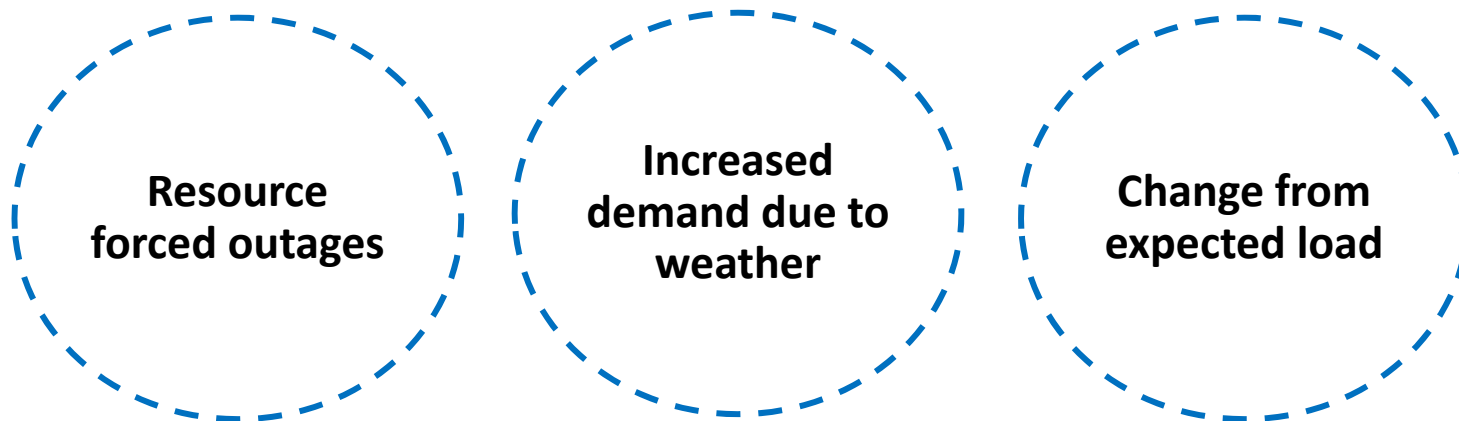


Portfolio Evaluation Framework

Portfolio	Resource Mix	Attributes and Weightings					Score

Portfolio Reliability Requirement

- Planning Reserve Margin (PRM): power supply buffer that allows a utility to reliably serve customers
- Three primary drivers:



- Dependent on resource portfolio and is utility-specific
- Industry standard is Loss-Of-Load-Expectation (LOLE) of 1 day in 10 years

Questions?

Wrap Up & Next Steps

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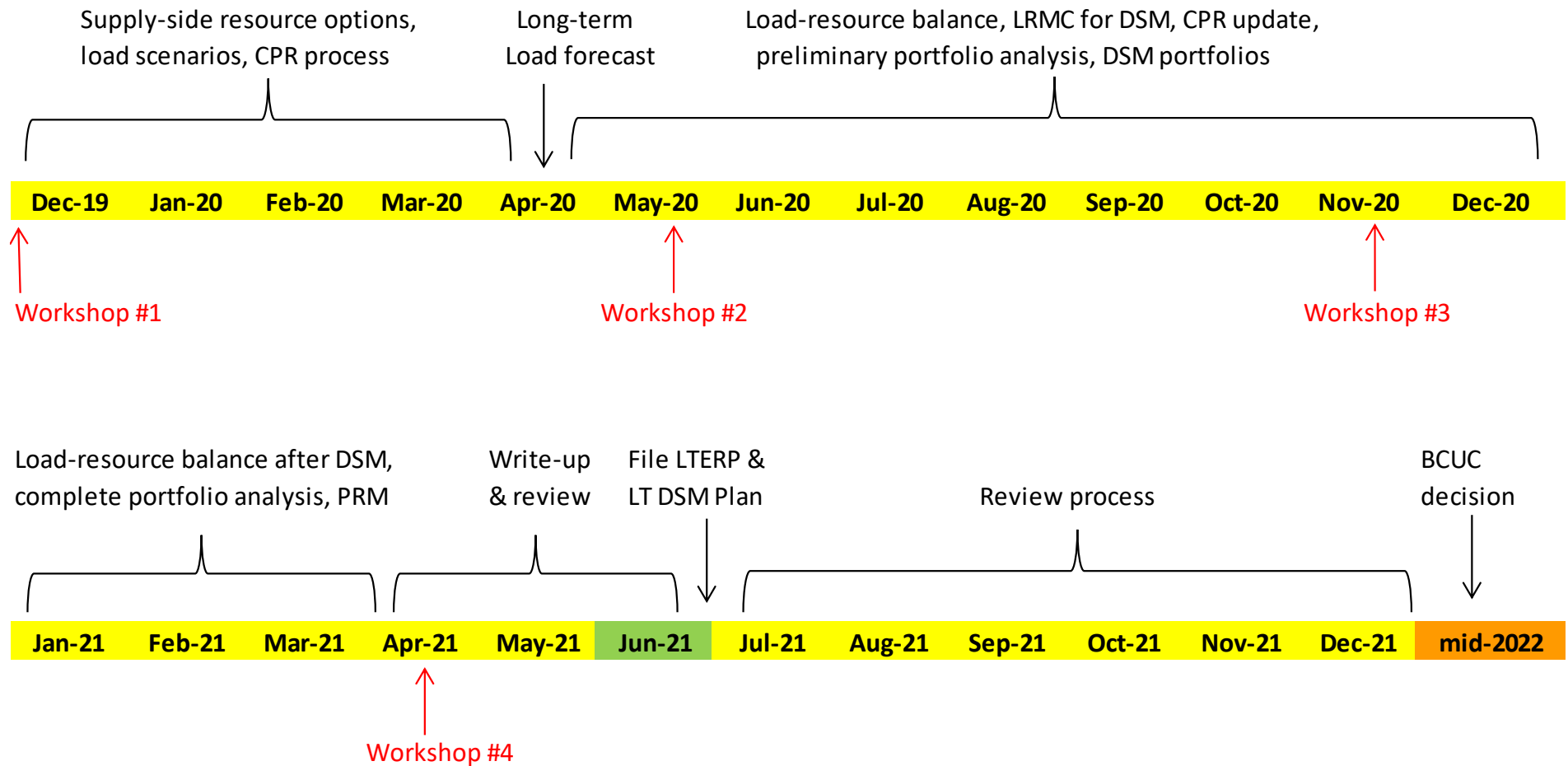
FBC Next Steps

- Prepare meeting notes and post on website
- Review the feedback
- Continue the LTERP development process
- Plan next workshop (spring 2020)

- FBC Resource Planning Website:

www.fortisbc.com/about-us/projects-planning/electricity-projects-planning/electricity-resource-planning

LTERP Development Timeline



Next Workshop Topics

- Updated long-term load forecasts
- Load scenarios preliminary results
- CPR update
- Supply-side resource options costs/attributes
- Gas, power, carbon price and PPA rate scenarios

Feedback

- Please fill out the Feedback form
- Feel free to email any questions, comments



**For further information,
please contact:**

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www.fortisbc.com/about-us/projects-planning/electricity-projects-planning/electricity-resource-planning

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