FortisBC Resource Planning Advisory Group

2017 LTGRP – Workshop 2

April 11, 2017

Energy at work FORTIS BC™

Safety Message

- Identify the location of emergency exits
- Determine the muster location in case we have to evacuate the building
- Dial 911 for emergencies
- Earthquake Awareness:

Introductions

RPAG Members:

- Name and Affiliation
- One energy related item that has caught your attention

FortisBC Staff:

- Name and role as it relates to the LTGRP
- One energy related item that has caught your attention

Welcome Message

Dennis Swanson
Vice President of Energy Supply

FortisBC

Introduction & objectives

Feedback from Workshop 1

Annual Demand Reference Case

Scenario Analysis Review

System Capacity Planning

Wrap-Up & Next Steps

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2017 LTGRP Timeline

Fall RPAG Workshop (November 2016)

- Introduction
- Planning environment
- Scenario analysis methods & qualitative inputs

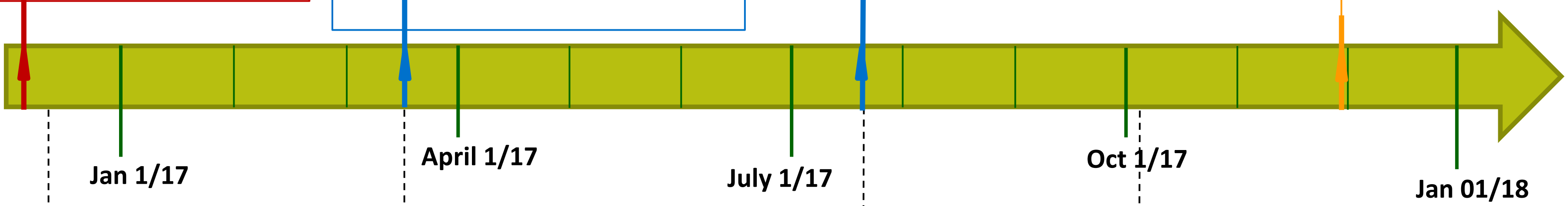
Spring RPAG Workshop (April 2017)

- Annual demand forecast results
- Quantitative scenario analysis review
- System capacity planning methods

Summer RPAG Workshop (June 2017)

- NGT annual demand forecast results
- DSM analysis results
- System requirements and options
- Regional supply resource options
- Site visit?

Submit LTGRP to BCUC Nov. 30, 2017



- Prepare customer and annual demand forecast
- Iterate quantitative scenario inputs
- Implement methods for linking annual and peak demand
- Update planning environment information
- Complete Conservation Potential Review (CPR)

- Prepare system requirements and options analysis
- Prepare regional supply resource analysis
- Complete DSM analysis

- Prepare directional rate and GHG impact analysis
- Finalize data integration
- Prepare regulatory submission document

LTGRP Regulatory Review

Purpose of the LTGRP

Problem Statement:

What resources must FortisBC have in place to supply customers' energy needs safely, reliably and cost-effectively over the next 20 years?

- Demand Side Management
- Natural Gas Supply
- Infrastructure

Please note

- Your contributions may be used for formulating our regulatory submission
- As such, your feedback may become public during the regulatory process
- We will not attribute statements to individual workshop attendees

Introduction & objectives

Feedback from Workshop 1

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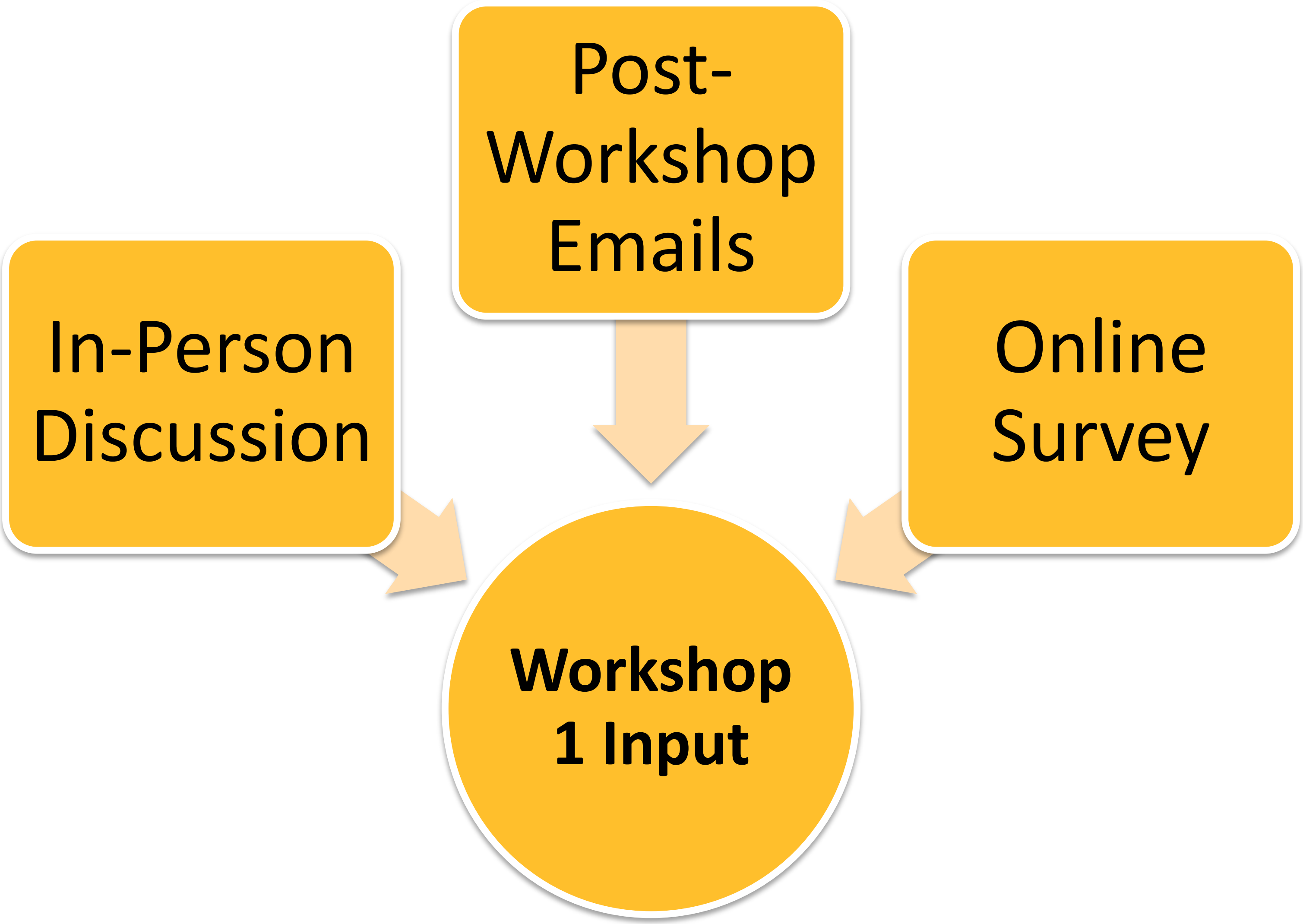
Wrap-Up & Next Steps

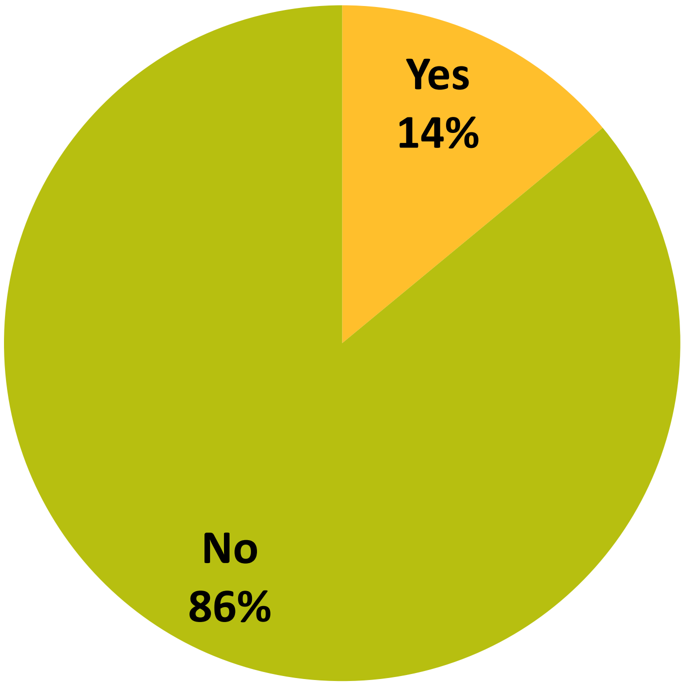
Energy at work FORTIS BC™

Thank you for your active engagement



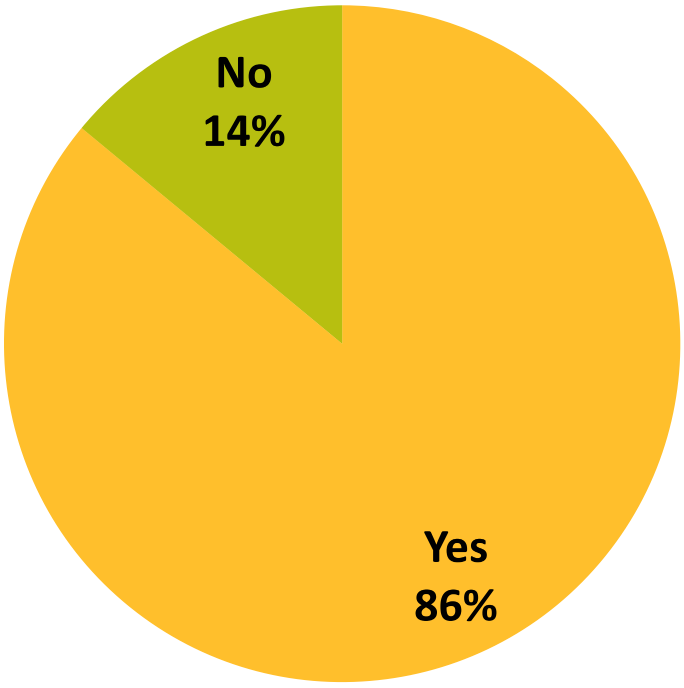
Half of Workshop 1 attendees participated in the online survey

Has FortisBC missed or misinterpreted any critical developments in the planning environment?



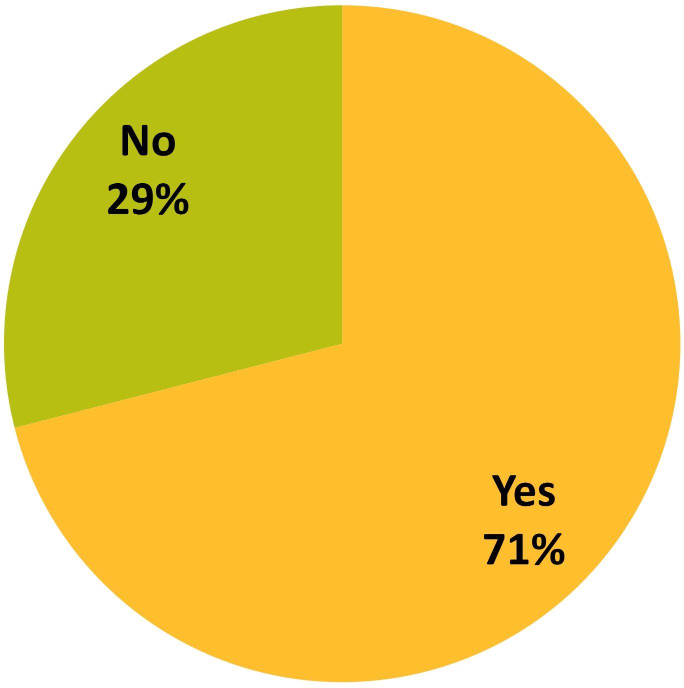
Half of Workshop 1 attendees participated in the online survey

Has FortisBC clearly explained how it is approaching the scenario analysis?



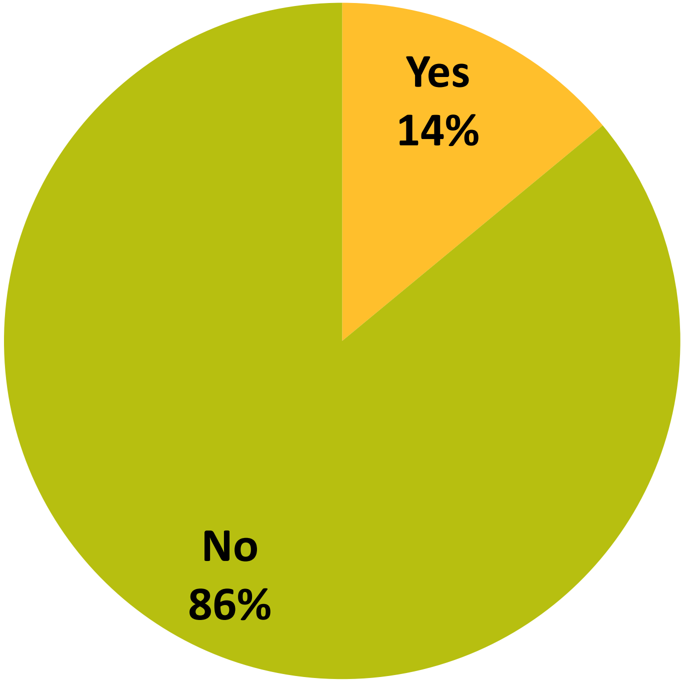
Half of Workshop 1 attendees participated in the online survey

Is FortisBC's scenario building approach reasonable?



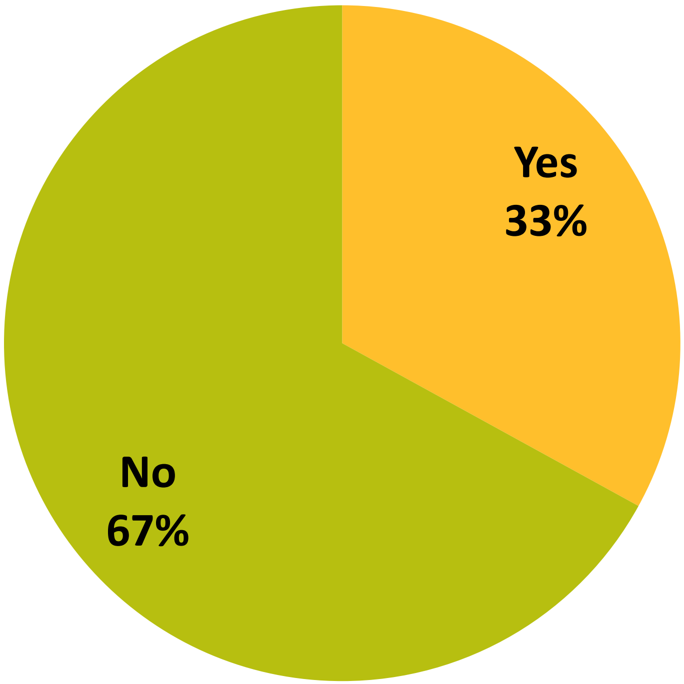
Half of Workshop 1 attendees participated in the online survey

Do you recommend alternative approaches (to FortisBC's statistical approach) for approximating economic growth?



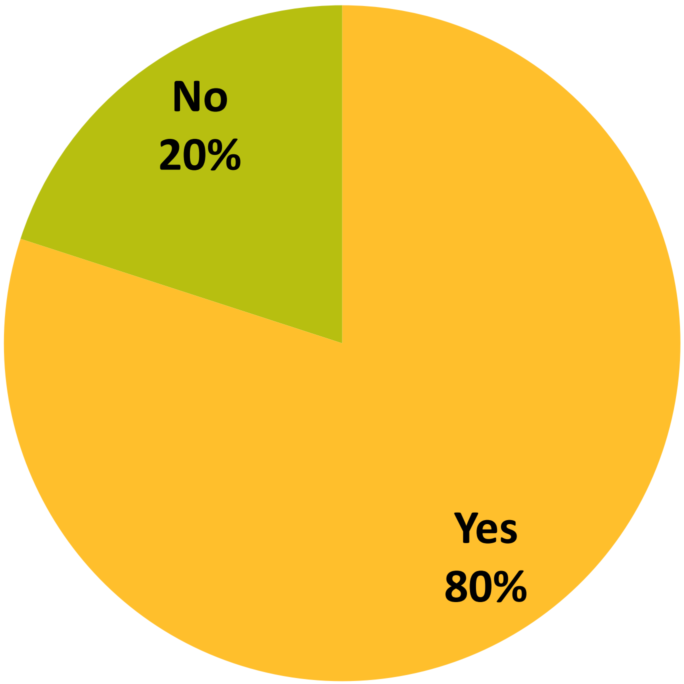
Half of Workshop 1 attendees participated in the online survey

Given potential shifts in US energy policy, should FortisBC consider a more conservative boundary for the delayed policy outcome?



Half of Workshop 1 attendees participated in the online survey

Are the storylines in FortisBC's intermediate scenarios reasonable?



We received additional qualitative input – stakeholder engagement process

Input Theme	FortisBC Implementation
Clarify purpose of the resource plan to help focus the discussion	Recap at start of input gathering activities
Meet in person soon to further discuss the scenario assumptions	Adjusted agenda for April 11 workshop

We received additional qualitative input – analysis process

Input Theme	FortisBC Implementation
Consider difference between policy targets and implemented policy actions to achieve such targets	Clarified approach for each critical uncertainty
Ensure scenarios contain rich, multi-layered plotlines	Considered resource plan objectives & moderately increased richness

We received additional qualitative input – report commentary

Input Theme	FortisBC Implementation
Include cost effective GHG emissions reductions in planning objectives	Ongoing discussions with FortisBC Regulatory and senior leadership
Recognize recorded First Nations statements to institutionalize these in public discourse	Ongoing discussions with FortisBC Regulatory and Community & Indigenous Relations

- Introduction & objectives
- Feedback from Workshop 1
- **Annual Demand Reference Case**
- Scenario Analysis Review
- System Capacity Planning
- Wrap-Up & Next Steps

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Traditional Forecast

Definitions

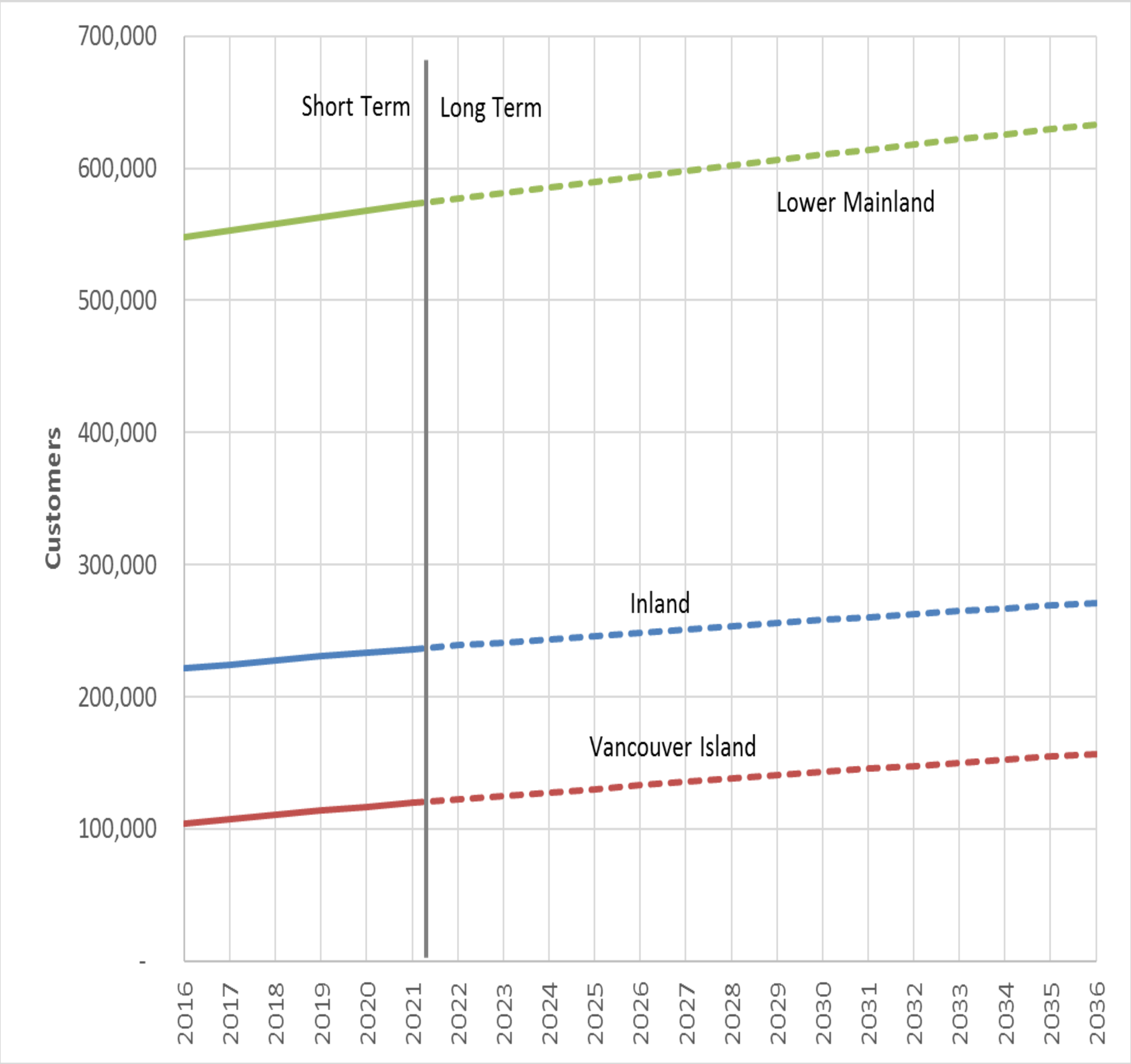
A time series forecast that relies on detailed actual data from our customers

Methods identical to short term (financial) forecasts

Good accuracy, particularly in the short term

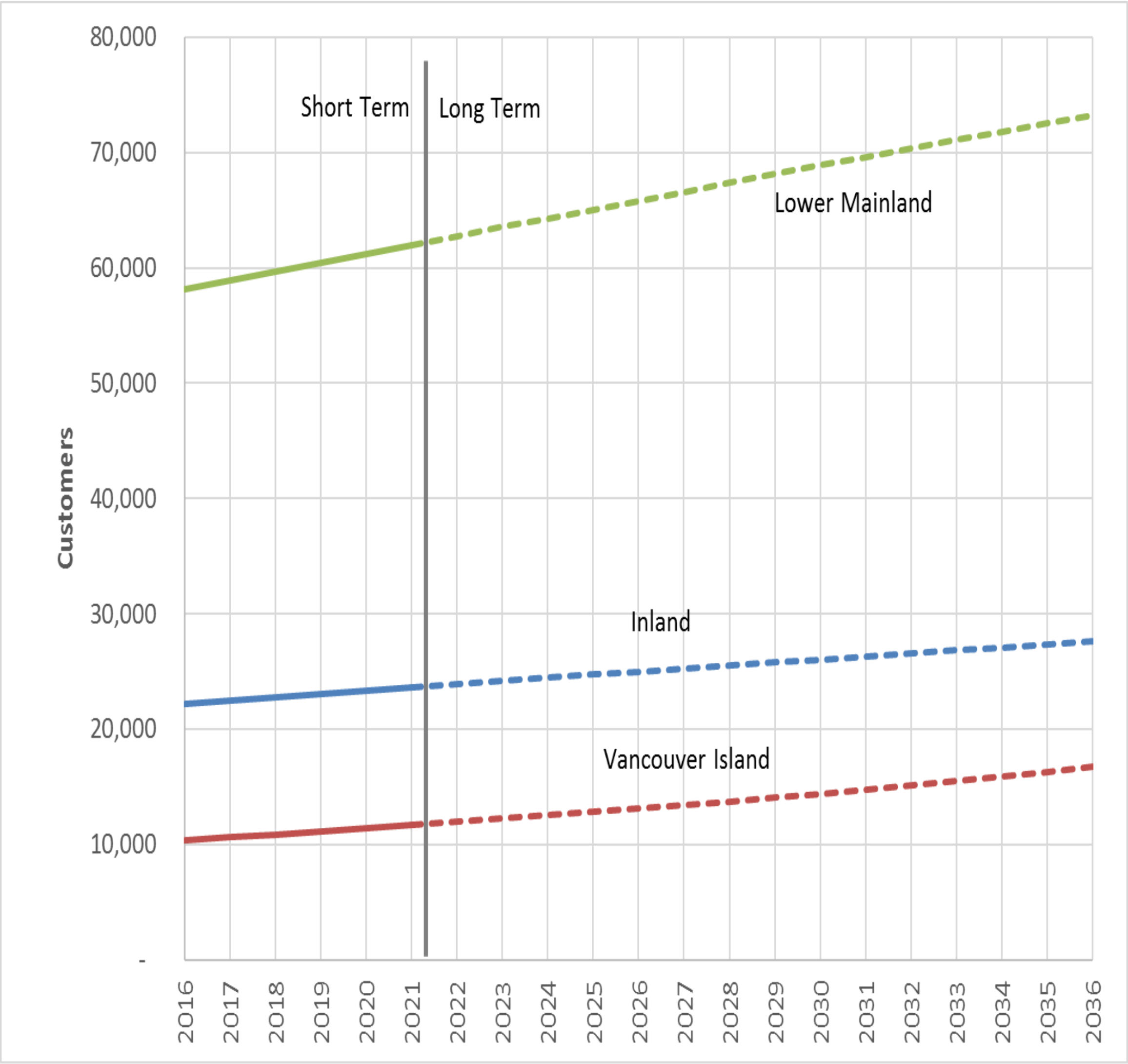
“Business as usual” in the long term

Residential Customers



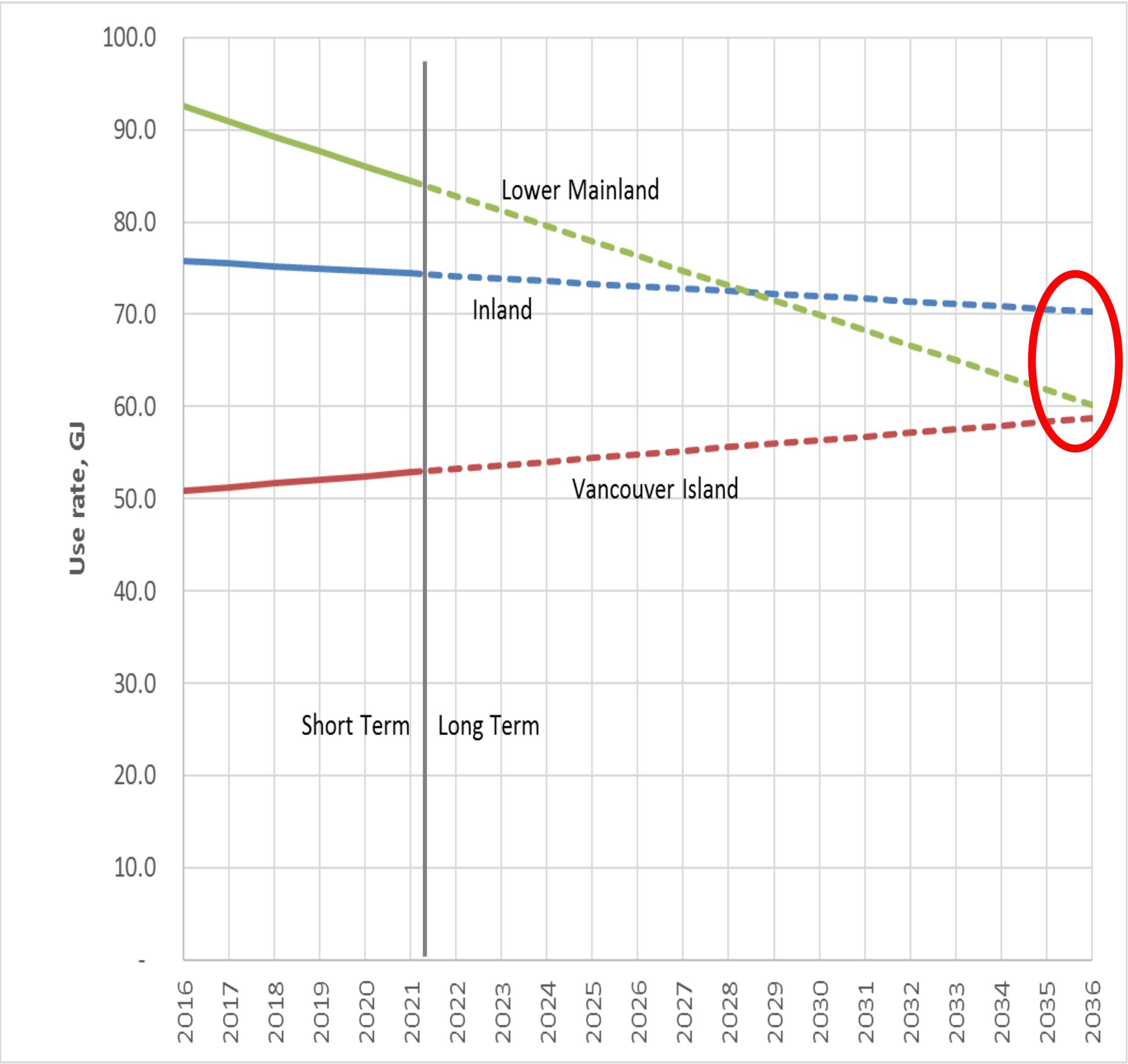
- Apply the growth rate from the long term CBOC forecast to the 2015 customer additions
- Single and multi-family forecast independently
- The first five years match the most recent short term forecast

Commercial Customers



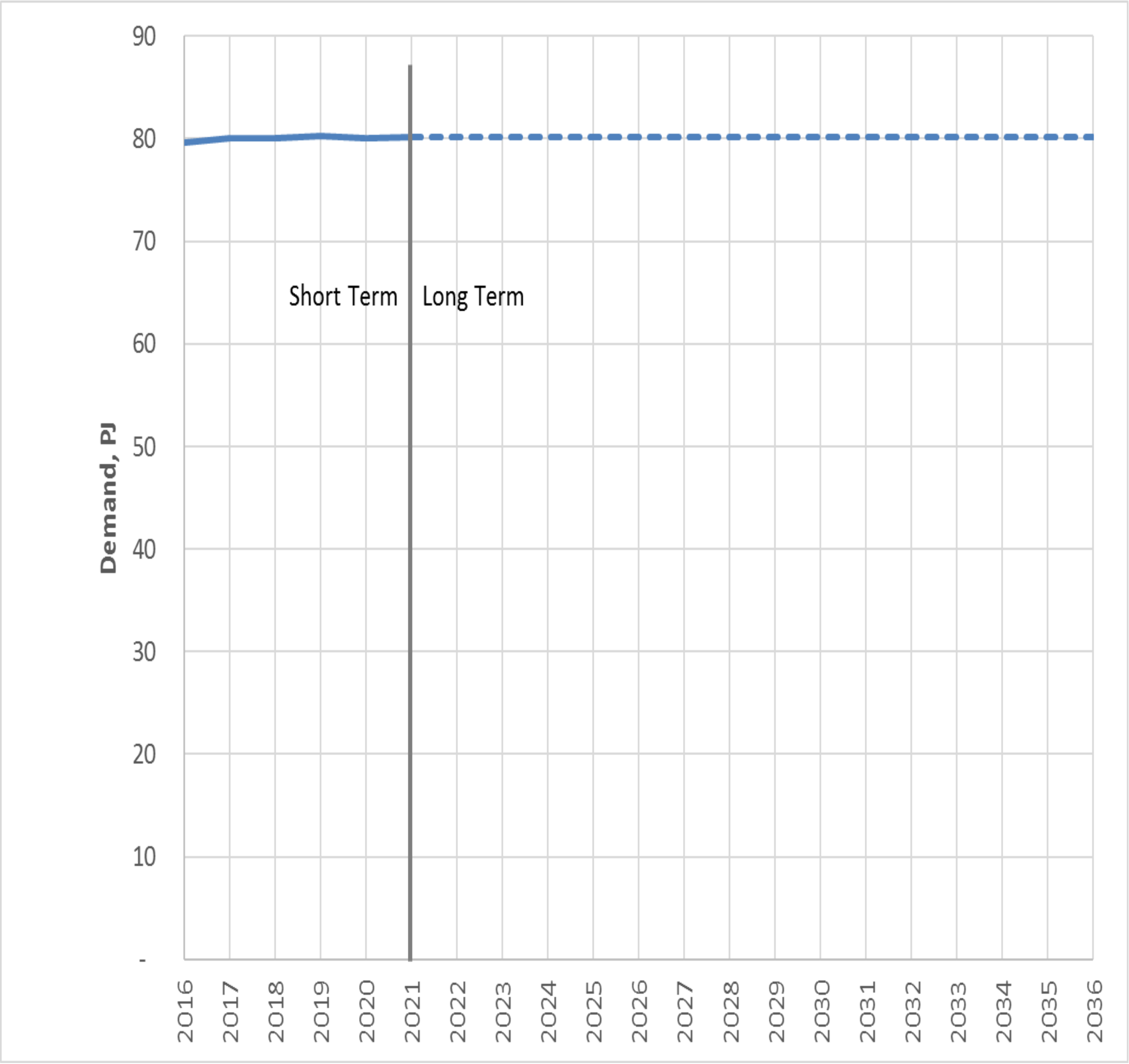
- First 5 years: Uses the most recent short term forecast
- Final 15 years: Based on BC STATS forecast

Residential Use Rate



- First 5 years: Uses the most recent short term forecast
- Final 15 years: Continuation of the time series regression from the first five years

Industrial Forecast



Industrial Demand

- First 5 years: Uses the most recent Industrial Survey
- Final 15 years: Held constant at the level of the final year of the survey

Transitioning to an End Use Forecast

Time Series Pros

- Based on our own customers
- All factors are intrinsic and therefore accounted for

Time Series Cons

- Assumes behavior today will not change
- Forecasts are straight lines – there can be no inflection points

End Use advantages

- Models each appliance independently
  - Use rate
  - Adoption rate
  - Standards

2017 Long-Term Gas Resource Plan (LTGRP)

Worked Example

April 11, 2017

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Exceptional Analytics and Advisory Services for the Energy Industry

Agenda

1. Introduction
   - ✓ About the Worked Example
   - ✓ Consumption Equation
   - ✓ Definitions and Acronyms
2. Base Year: 2015
3. Reference Case: 2016
4. Reference Case: 2022
5. Forecast: 2016-2036

About the Worked Example (1 of 3)

- ✓ The model and its methods are transparent, but not simple. We focus in on one specific case and detail how consumption was calculated as an illustration of how the model functions.
- ✓ The worked example will show how consumption was calculated for three specific years during the forecast:

I. 2015 (the base year),

II. 2016 (the first year of the forecast), and;

III. 2022.

- ✓ Annual consumption for the forecast period (2016-2036) is presented at the end.

About the Worked Example (2 of 3)

The worked example case is specific to:

- ✓ Sector: residential (Rate 1)
- ✓ End-use: space heating (SH)
- ✓ Building type: single-family dwellings (SFD)
- ✓ Vintage: middle-age, built between1976-2005 (denoted ‘G’)
- ✓ Predominant heating fuel: natural gas (i.e. gets more than half its heating energy from gas), (denoted ‘M’)
- ✓ Region: Lower Mainland (LML).

✓ Calculations throughout the example will denote the year and specifics as required.

✓ Please see handout with notation to follow along through the worked example.

✓ Example subscript for worked example: $G - M, SFD, LML, SH$

About the Worked Example (3 of 3)

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	C	D	E	F	G	I	L	M	O	P	S	Y	AA
1	Sector	Scenario	Region	Fuel	Rate Cl	End Use	Year	Existin	Main Heating Fuel	Segment Vintage	Segme	Units	Consumption
4094	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Clothes Dryer	2015	Existing	Gas Heat	1976-2005	SFD	212,927	51,591
4095	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Clothes Washer	2015	Existing	Gas Heat	1976-2005	SFD	212,927	-
4096	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Cooking	2015	Existing	Gas Heat	1976-2005	SFD	212,927	286,139
4097	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Dishwasher	2015	Existing	Gas Heat	1976-2005	SFD	212,927	-
4098	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Domestic Hot Water (DHW)	2015	Existing	Gas Heat	1976-2005	SFD	212,927	3,654,571
4099	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Fireplace	2015	Existing	Gas Heat	1976-2005	SFD	212,927	2,932,744
4100	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Other Electrical Internal Loads	2015	Existing	Gas Heat	1976-2005	SFD	212,927	-
4101	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Other Gas Uses	2015	Existing	Gas Heat	1976-2005	SFD	212,927	443,696
4102	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Pool & Spa Heaters	2015	Existing	Gas Heat	1976-2005	SFD	212,927	235,112
4103	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Space Cooling	2015	Existing	Gas Heat	1976-2005	SFD	212,927	-
4104	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Space Heating	2015	Existing	Gas Heat	1976-2005	SFD	212,927	13,029,669
4105	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Ventilation and Circulation	2015	Existing	Gas Heat	1976-2005	SFD	212,927	-
4106	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Clothes Dryer	2016	Existing	Gas Heat	1976-2005	SFD	212,927	51,591
4107	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Clothes Washer	2016	Existing	Gas Heat	1976-2005	SFD	212,927	-
4108	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Cooking	2016	Existing	Gas Heat	1976-2005	SFD	212,927	286,139
4109	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Dishwasher	2016	Existing	Gas Heat	1976-2005	SFD	212,927	-
4110	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Domestic Hot Water (DHW)	2016	Existing	Gas Heat	1976-2005	SFD	212,927	3,645,132
4111	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Fireplace	2016	Existing	Gas Heat	1976-2005	SFD	212,927	2,913,602
4112	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Other Electrical Internal Loads	2016	Existing	Gas Heat	1976-2005	SFD	212,927	-
4113	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Other Gas Uses	2016	Existing	Gas Heat	1976-2005	SFD	212,927	443,696
4114	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Pool & Spa Heaters	2016	Existing	Gas Heat	1976-2005	SFD	212,927	235,112
4115	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Space Cooling	2016	Existing	Gas Heat	1976-2005	SFD	212,927	-
4116	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Space Heating	2016	Existing	Gas Heat	1976-2005	SFD	212,927	12,911,668
4117	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Ventilation and Circulation	2016	Existing	Gas Heat	1976-2005	SFD	212,927	-
4118	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Clothes Dryer	2016	New	Gas Heat	1976-2005	SFD	65	16
4119	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Clothes Washer	2016	New	Gas Heat	1976-2005	SFD	65	-
4120	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Cooking	2016	New	Gas Heat	1976-2005	SFD	65	87
4121	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Dishwasher	2016	New	Gas Heat	1976-2005	SFD	65	-
4122	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Domestic Hot Water (DHW)	2016	New	Gas Heat	1976-2005	SFD	65	1,113
4123	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Fireplace	2016	New	Gas Heat	1976-2005	SFD	65	755
4124	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Other Electrical Internal Loads	2016	New	Gas Heat	1976-2005	SFD	65	-
4125	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Other Gas Uses	2016	New	Gas Heat	1976-2005	SFD	65	135
4126	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Pool & Spa Heaters	2016	New	Gas Heat	1976-2005	SFD	65	72
4127	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Space Cooling	2016	New	Gas Heat	1976-2005	SFD	65	-
4128	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Space Heating	2016	New	Gas Heat	1976-2005	SFD	65	3,942
4129	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Ventilation and Circulation	2016	New	Gas Heat	1976-2005	SFD	65	-
4130	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Clothes Dryer	2017	Existing	Gas Heat	1976-2005	SFD	212,927	51,528
4131	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Clothes Washer	2017	Existing	Gas Heat	1976-2005	SFD	212,927	-
4132	Residential	Reference Case	Lower Mainland	Natural Gas	RATE1	Cooking	2017	Existing	Gas Heat	1976-2005	SFD	212,927	285,785

Consumption Equation

$$Consumption = Units \times Saturation \times Fuel\,Share \times UEC$$

Definitions

Term	Definition	Expressed As	Equation
Consumption	The annual amount of natural gas consumed by an end-use, expressed in gigajoules.	Gigajoules (GJ)	$Consumption = Units \times Saturation \times Fuel\ Share \times UEC$
Units	The basis for how energy consumption is expressed in each sector.	Number of dwellings (residential); m² of floor area (commercial); plant capacity in base year GJ (industrial)	$2015\ Units_{Residential} = Customers$ $Units\ beyond\ 2015_{Residential} = Customers_{2015} \times Growth\ Rate_{Rate\ 1}$
Saturation	The extent to which an end-use is present in that sector, region, rate class, and building type.	Percentage	$Saturation_X = \frac{\#\ of\ appliances\ providing\ X}{\#\ of\ dwellings}$
Fuel Share	The percentage of the energy end-use that is supplied by natural gas.	Percentage	$Shares_X = \frac{Natural\ Gas\ Fuelled\ X}{All\ X}$
Unit Energy Consumption (UEC)	The amount of energy used by each end use per unit.	$\frac{GJ}{dwelling}$	$UEC = \frac{Consumption}{End\ Use\ Count}$

Acronyms

- ✓ Residential End-Use Survey (REUS)
- ✓ Conservation Potential Review (CPR)

Base Year (2015)

Worked Example

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About the Base Year

- The LTGRP begins by developing a "base year." 2015 is the base year for the 2017 LTGRP and is based on actual consumption data for that year.
- The consumption data supplied was broken down by geographic region, sector, rate class, building type (using NAICS codes).
- PG further apportioned consumption by end use.

Base Year: 2015

Step 1: Set units

$$Units_{2015,G-M,SFD,LML} = Customers_{G-M,SFD,LML}$$

$$Units_{2015,G-M,SFD,LML} = 212{,}927\ dwellings$$

Base Year: 2015

POSTERITY GROUP

Step 2: Set saturation

$$Saturation_{SH} = 100\%$$

Base Year: 2015

Step 3: Calculate fuel share

$$SH\ Fuel\ Share_{2015} = SH\ Fuel\ Share_{2016\ CPR} \times \frac{SH\ Fuel\ Share_{2012\ REUS}}{SH\ Weighted\ Fuel\ Share_{2012\ REUS}}$$

$$SH\ Fuel\ Share_{2015} = 0.889 \times \frac{0.945}{0.883}$$

$$SH\ Fuel\ Share_{2015} = 0.952$$

Base Year: 2015

POSTERITY GROUP

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

Weighted Average (2014)

[redacted]

Weighted Average (CPR)

[redacted]

Base Year: 2015

POSTERITY GROUP

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

Weighted Average (2014)

[redacted]

Weighted Average (CPR)

[redacted]

Base Year: 2015

Step 4: Calculate UEC (1 of 2)

$$UEC_{2015,G-M\ SFD,LML,SH} = UEC_{2016\ CPR\ SFD} \times \frac{UEC_{2014\ LTRP,G-M\ SFD,LML,SH}}{UEC_{2014\ LTRP,LML,SFD,SH}}$$

$$UEC_{2015,G-M\ SFD,LML,SH} = 65.3 \times \frac{77.9}{89.3}$$

$$UEC_{2015,G-M\ SFD,LML,SH} = 56.9\ \frac{GJ}{dwelling}$$

Base Year: 2015

Step 4: Calculate UEC (2 of 2)

$$UEC_{2015} = 56.9 \times 1.1$$

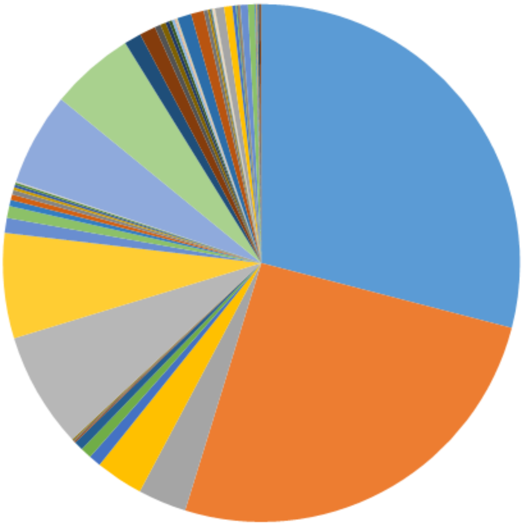
$$UEC_{2015} = 64.3 \ \frac{GJ}{dwelling}$$

Base Year: 2015

Step 4: Calculate UEC (2 of 2)

$$UEC_{2015} = 56.9 \times 1.1$$

$$UEC_{2015} = 64.3 \frac{GJ}{dwelling}$$



Very nice, but a bit too small

Base Year: 2015

Step 5: Calculate consumption

$$Consumption_{2015} = Units \times Saturation \times Fuel\,Share \times UEC$$

$$Consumption_{2015} = 212{,}927\ dwellings \times 1 \times 0.952 \times 64.3\ \frac{GJ}{dwelling}$$

$$Consumption_{2015} = 13{,}029{,}669\ \mathrm{GJ}$$

Reference Case (2016)

Worked Example

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About the Reference Case

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- The reference case is the forecast of natural gas consumption over a twenty-year (2016-2036) period based on “business-as-usual” exogenous conditions.
- The reference case starts with the base year, then forecasts consumption to 2036.

Reference Case: 2016

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Step 1: Calculate units (1 of 3)

- We assumed there was no demolition so the number of existing units stays constant.
- Growth in the number of customers in this segment occurs when existing dwellings convert to natural gas for their predominant heating fuel.
- FEI provided the customer account forecast by rate class.

Reference Case: 2016

Step 1: Calculate units (2 of 3)

$$Units_{2016} = \frac{\#\ of\ units_{2015\ Rate\ 1} + (\#\ of\ new\ units_{2016\ Rate\ 1}) \times \frac{Annual\ growth\ rate_{conversions\ LML}}{Weighted\ average\ growth\ rate_{LML}}}{\#\ of\ units_{2015\ Rate\ 1}} \times \#\ of\ units_{2015\ Rate\ 1\ LML}$$

$$Units_{2016} = \frac{876{,}145 + (11{,}875) \times (\frac{0.02\%}{0.96\%})}{876{,}145} \times\ 212{,}927$$

$$Units_{2016} = 212{,}992$$

Reference Case: 2016

Step 1: Calculate units (3 of 3)

$$Number\ of\ New\ Customers_{2015\ to\ 2016} = Number\ of\ Customers_{2016} - Number\ of\ Customers_{2015}$$

$$Number\ of\ New\ Customers_{2015\ to\ 2016} = 212{,}992 - 212{,}927$$

$$Number\ of\ New\ Customers_{2015\ to\ 2016} = 65$$

Reference Case: 2016

Step 2: Set saturation

$$Saturation_{SH} = 100\%$$

Reference Case: 2016

Step 3: Set fuel share

$$SH\ Fuel\ share_{2016} = SH\ Fuel\ share_{2015}$$
$$SH\ Fuel\ share_{2016} = 0.952$$

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Step 4: Calculate UEC (1 of 3)

$$Shell\ Improvements_{SH} = \frac{Tertiary\ Load_{2016}}{Tertiary\ Load_{2015}}$$

$$Shell\ Improvements_{SH} = \frac{51.69\ {}^{GJ}/_{dwelling}}{51.75\ {}^{GJ}/_{dwelling}}$$

$$Shell\ Improvements_{SH} = 0.999$$

Reference Case: 2016

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Step 4: Calculate UEC (2 of 3)

$$Efficiency\ Improvements_{Furnace} = \frac{Efficiency_{2015}}{Efficiency_{2016}}$$

$$Efficiency\ Improvements_{Furnace} = \frac{0.805}{0.812}$$

$$Efficiency\ Improvements_{Furnace} = 0.992$$

Reference Case: 2016

Step 4: Calculate UEC (3 of 3)

$$UEC_{2016} = UEC_{2015} \times Shell\ Improvements \times Efficiency\ Improvements$$

$$UEC_{2016} = 64.3 \times 0.999 \times 0.992$$

$$UEC_{2016} = 63.7$$

Reference Case: 2016

Step 5: Calculate consumption

$$Consumption_{2016} = Units \times Saturation \times Fuel\ Share \times UEC$$

$$Consumption_{2016} = 212{,}992\ dwellings \times 1 \times 0.952 \times 63.7 \frac{GJ}{dwelling}$$

$$Consumption_{2016} = 12{,}915{,}610\ GJ$$

- Of the consumption in 2016:
  - 12,911,668 GJ is from the 212,927 existing customers; and
  - 3,942 GJ is from the 65 new customers.

Reference Case (2022)

Worked Example

2016 to 2022

- Continued customer growth based on FEI account forecast
- Saturation remains constant for space heating
- UEC changes (decreases) as:
  - Furnaces and boilers are replaced upon reaching end of life
  - New equipment has improved efficiency
  - Continued natural changes in insulation and windows
- Fuel share for natural gas decreases as renewable natural gas is added to the model as a substitute

Reference Case: 2022

Step 1: Calculate units (1 of 2)

$$Units_{2022} = \frac{\#\ of\ units_{2015\ Rate\ 1} + (\#\ of\ new\ units_{2022\ Rate\ 1}) \times \frac{Annual\ growth\ rate_{conversions\ LML}}{Weighted\ average\ growth\ rate_{LML}}}{\#\ of\ units_{2015\ Rate\ 1}} \times \#\ of\ units_{2015\ Rate\ 1\ LML}$$

$$Units_{2022} = \frac{876{,}145 + (78{,}062) \times (\frac{0.02\%}{0.96\%})}{876{,}145} \times\ 212{,}927$$

$$Units_{2022} = 213{,}354$$

Reference Case: 2022

Step 1: Calculate units (2 of 2)

$$Number\ of\ New\ Customers_{2015\ to\ 2022} = Number\ of\ Customers_{2022} - Number\ of\ Customers_{2015}$$

$$Number\ of\ New\ Customers_{2015\ to\ 2022} = 213{,}354 - 212{,}927$$

$$Number\ of\ New\ Customers_{2015\ to\ 2022} = 427$$

Reference Case: 2022

Step 2: Set saturation

$$Saturation_{SH} = 100\%$$

Reference Case: 2022

Step 3: Set fuel share

$$SH\ Fuel\ share_{2022} = 0.949$$

Reference Case: 2022

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Step 4: Calculate UEC (1 of 3)

$$Shell\ Improvements_{SH} = \frac{Tertiary\ Load_{2022}}{Tertiary\ Load_{2015}}$$

$$Shell\ Improvements_{SH} = \frac{51.39\ {}^{GJ}/_{dwelling}}{51.75\ {}^{GJ}/_{dwelling}}$$

$$Shell\ Improvements_{SH} = 0.993$$

Reference Case: 2022

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Step 4: Calculate UEC (2 of 3)

$$Efficiency\ Improvements_{Furnaces} = \frac{Efficiency_{2015}}{Efficiency_{2022}}$$

$$Efficiency\ Improvements_{Furnaces} = \frac{0.805}{0.847}$$

$$Efficiency\ Improvements_{Furnaces} = 0.951$$

Reference Case: 2022

Step 4: Calculate UEC (3 of 3)

$$UEC_{2022} = UEC_{2015} \times Shell\ Improvements \times Efficiency\ Improvements$$

$$UEC_{2022} = 64.3 \times 0.993 \times 0.951$$

$$UEC_{2022} = 60.7$$

Reference Case: 2022

Step 5: Calculate consumption

$$Consumption_{2022} = Units \times Saturation \times Fuel\ Share \times UEC$$

$$Consumption_{2022} = 213{,}354\ dwellings \times 1 \times 0.949 \times 60.7 \frac{GJ}{dwelling}$$

$$Consumption_{2022} = 12{,}289{,}048\ GJ$$

- Of the consumption in 2022:
  - 12,264,453 GJ is from the 212,927 existing customers; and
  - 24,595 GJ is from the 427 new customers.

Forecast(2016-2036)

Annual Consumption

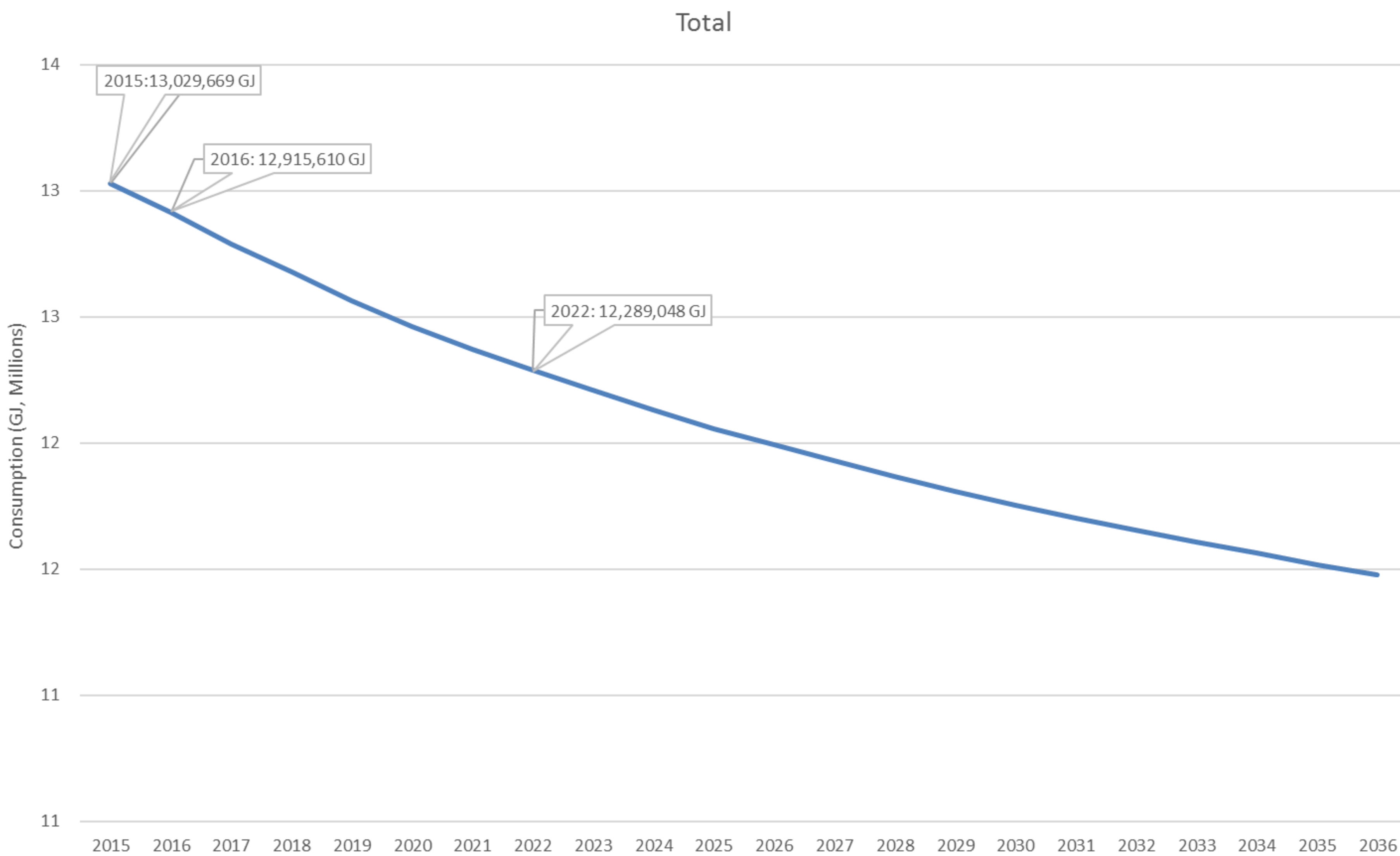
Forecasted Worked Example Inputs

POSTERITY GROUP

	Inputs				Ouput
Year	**Units**	**Saturation**	**Fuel Share**	**UEC**	**Consumption (GJ)**
2015	212,927	1	0.952	64.278	13,029,669
2016	212,992	1	0.952	63.696	12,915,610
2017	213,054	1	0.951	63.135	12,789,664
2018	213,117	1	0.950	62.593	12,676,985
2019	213,179	1	0.950	62.068	12,563,689
2020	213,241	1	0.949	61.561	12,460,167
2021	213,301	1	0.949	61.123	12,371,604
2022	213,354	1	0.949	60.701	12,289,048
2023	213,405	1	0.949	60.294	12,209,235
2024	213,455	1	0.949	59.900	12,132,033
2025	213,505	1	0.949	59.517	12,057,053
2026	213,557	1	0.949	59.185	11,992,368
2027	213,607	1	0.949	58.862	11,929,567
2028	213,658	1	0.949	58.549	11,868,664
2029	213,708	1	0.949	58.244	11,809,581
2030	213,757	1	0.949	57.949	11,752,251
2031	213,805	1	0.949	57.693	11,702,731
2032	213,852	1	0.949	57.443	11,654,630
2033	213,899	1	0.949	57.201	11,607,924
2034	213,945	1	0.949	56.966	11,562,536
2035	213,989	1	0.949	56.737	11,518,403
2036	214,032	1	0.949	56.514	11,475,327

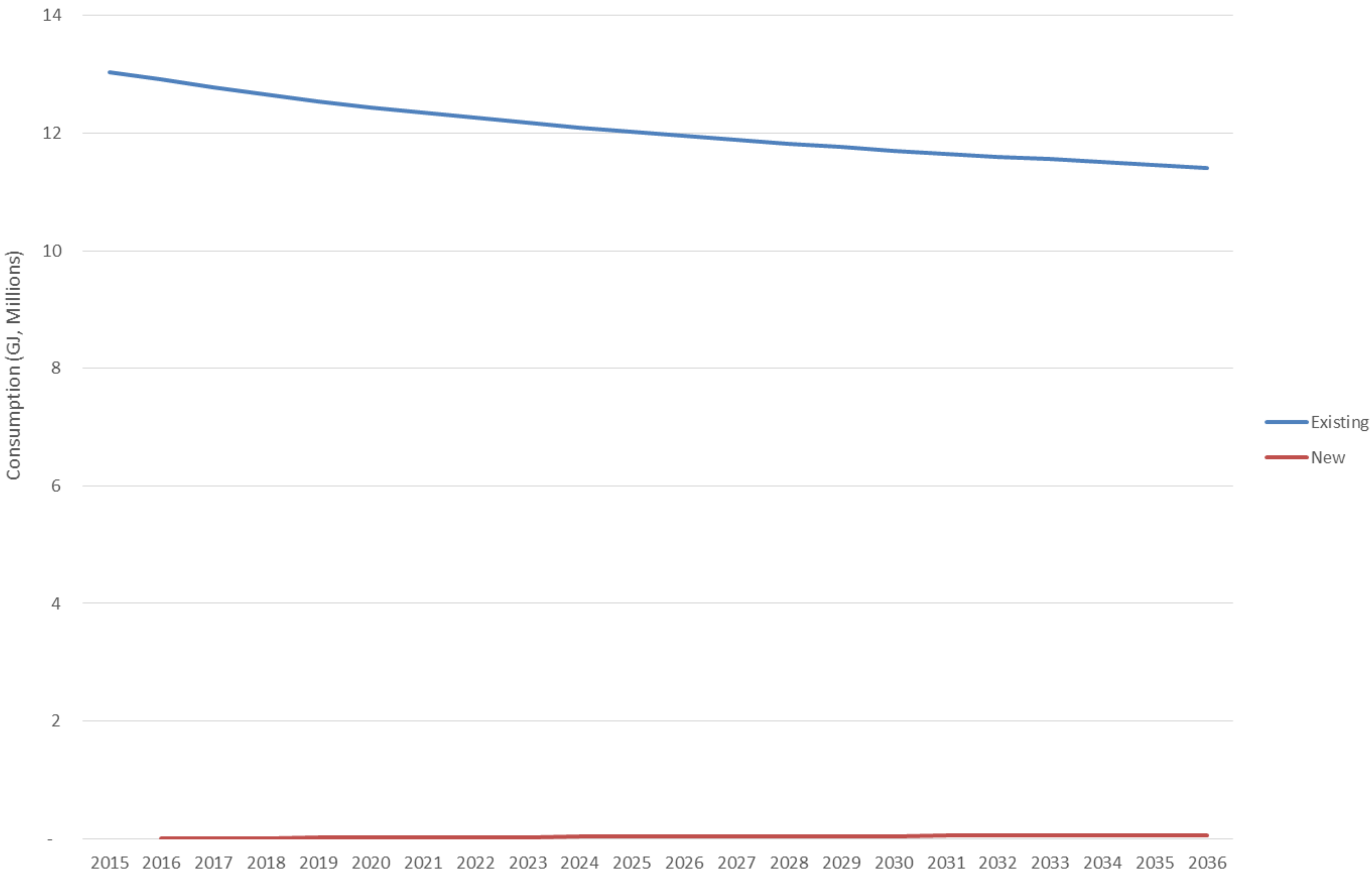
Note: The forecasted demand illustrated is specifically for Schedule Rate 1 residential customers in the Lower Mainland for space heating in single-family dwellings built between 1976-2005 that have natural gas as their predominant heating fuel.

Forecasted Demand for Worked Example



Note: The forecasted demand illustrated is specifically for Schedule Rate 1 residential customers in the Lower Mainland for space heating in single-family dwellings built between 1976-2005 that have natural gas as their predominant heating fuel.

Worked Example: Existing vs New Customers Forecasted Demand



Note: The forecasted demand illustrated is specifically for Schedule Rate 1 residential customers in the Lower Mainland for space heating in single-family dwellings built between 1976-2005 that have natural gas as their predominant heating fuel.

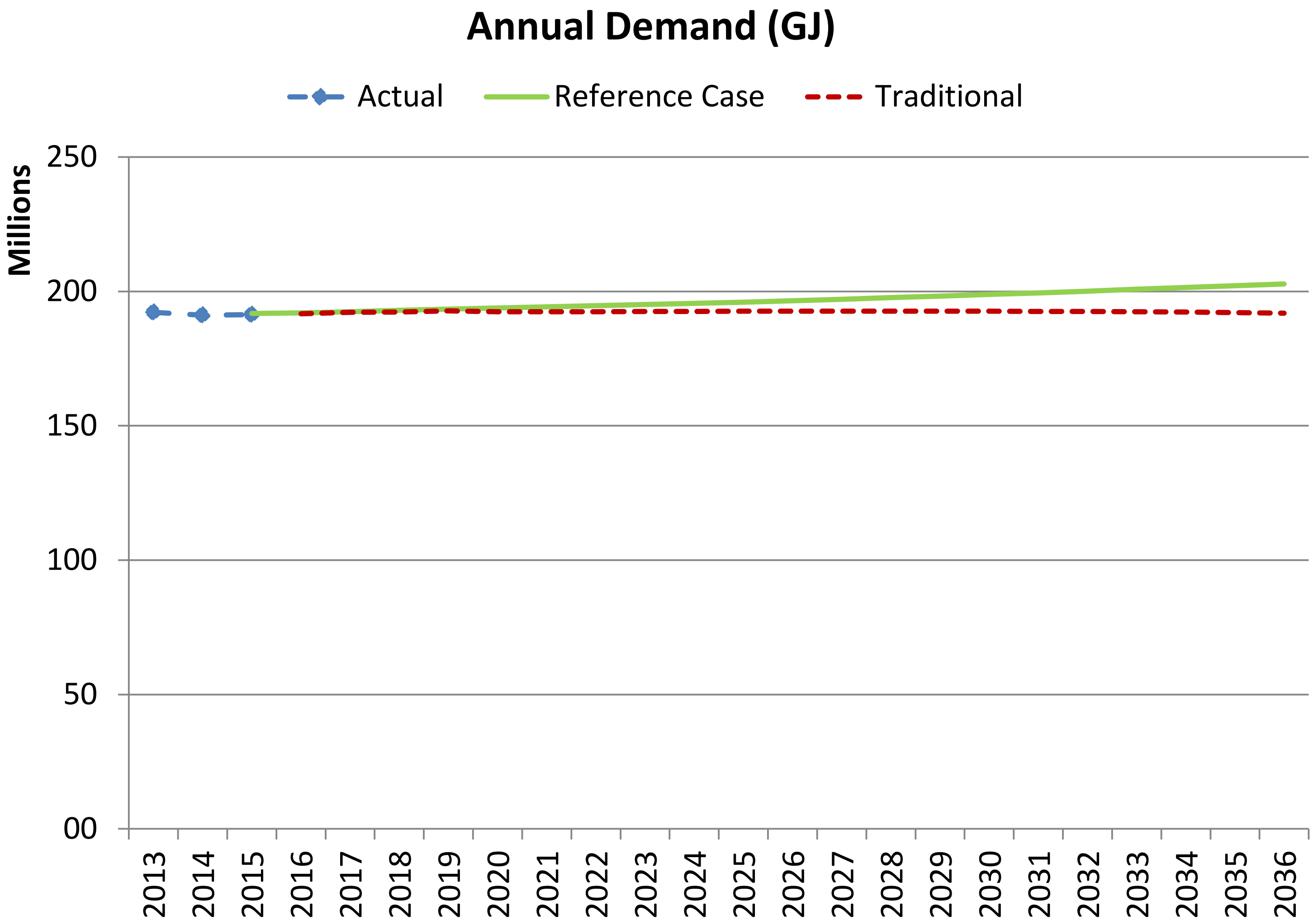
Questions?

Appendix

Exceptional Analytics and Advisory Services for the Energy Industry

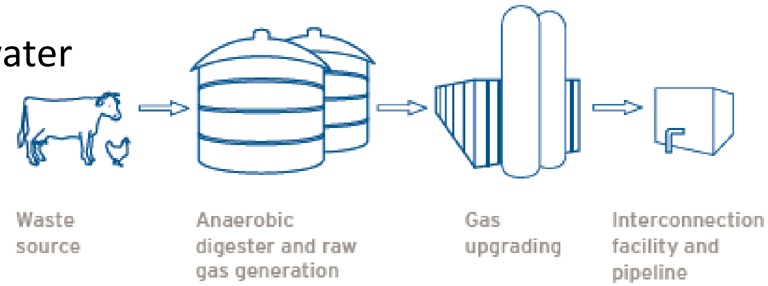
POSTERITY GROUP

The annual demand Reference Case

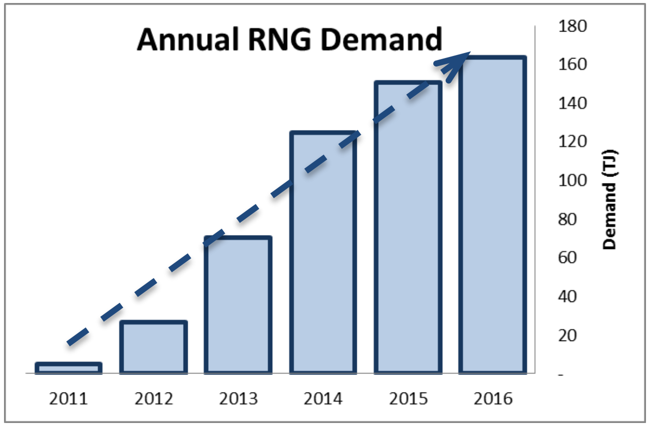


FortisBC Renewable Natural Gas "RNG"

- Uses methane generated from organic waste
  - Landfills, municipal organics, agricultural, wastewater
- Displaces conventional Natural Gas
- Injecting RNG since Fall 2010
- Currently four projects + three in progress



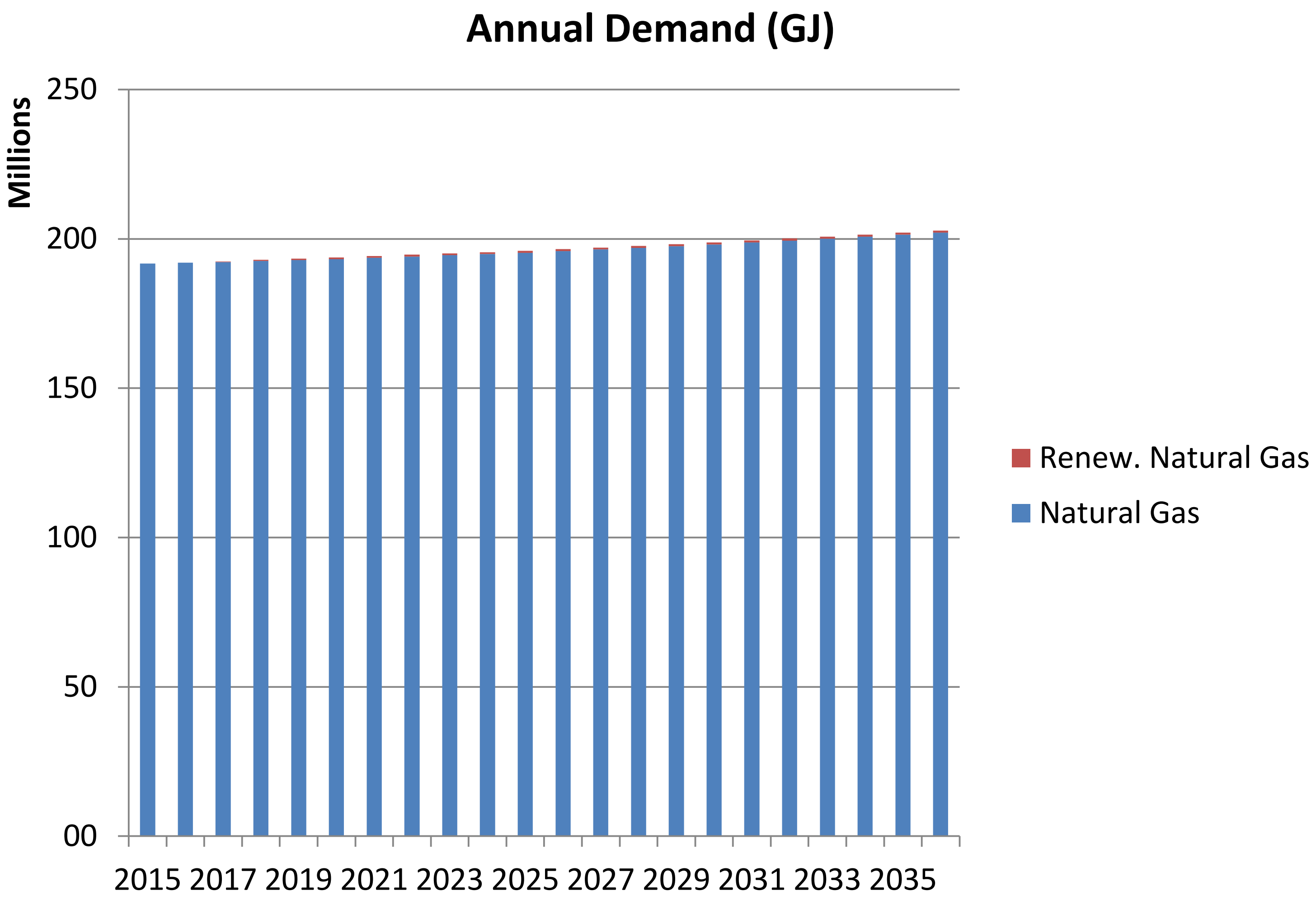
- Residential Participation began 2011
- Customer chooses a blend of RNG
- Currently more than about 7,800 Customers



> 28,000 tonne CO2e in GHG savings since launch

RNG Demand from customers has increased each year

Renewable Natural Gas will account for a minimal slice of future annual demand

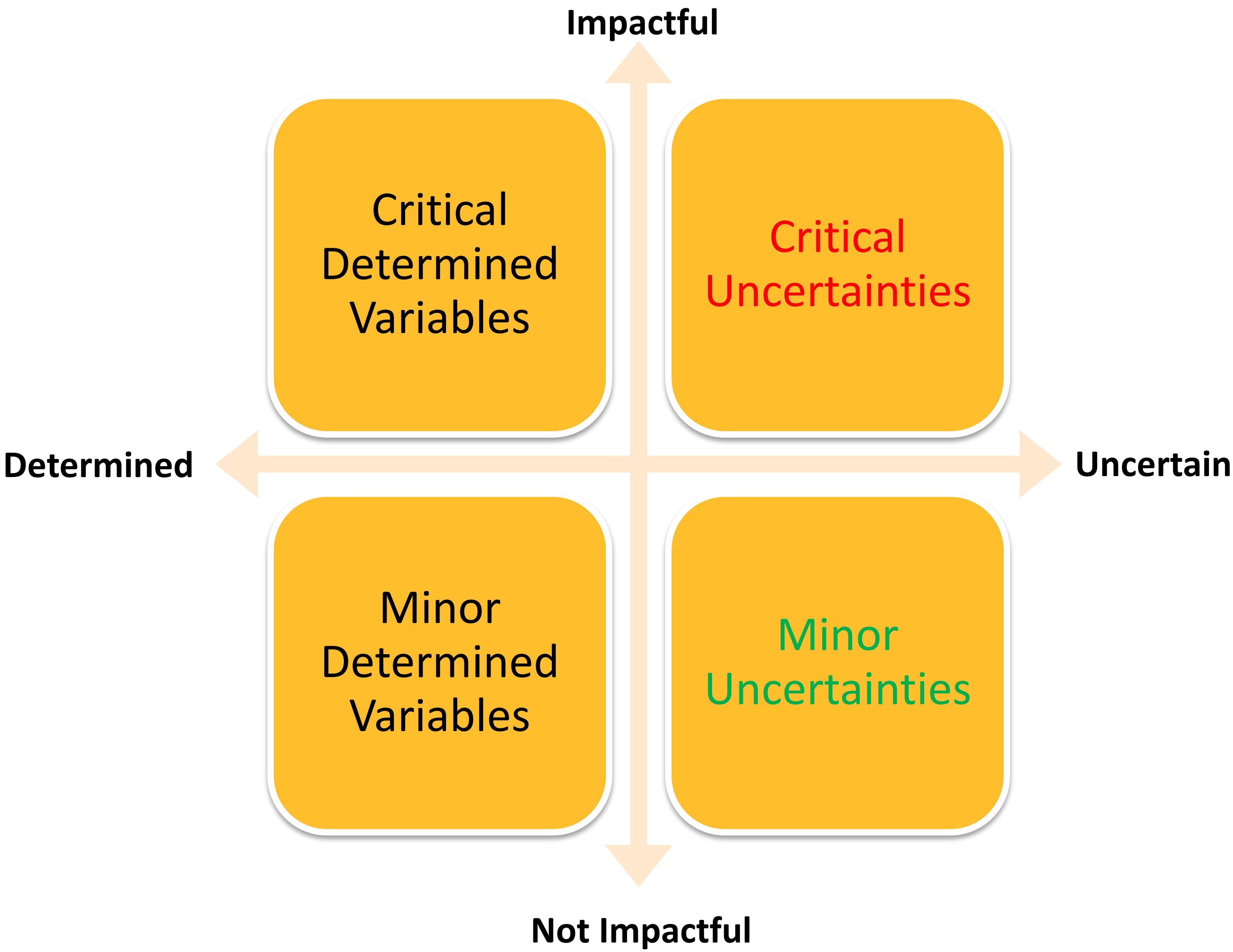


Supplier Video

- Introduction & objectives
- Feedback from Workshop 1
- Annual Demand Reference Case
- **Scenario Analysis Review**
- System Capacity Planning
- Wrap-Up & Next Steps

Energy at work FORTIS BC™

How do we assess scenario factors?



Building scenarios from the critical uncertainties – historical steps

1. Describe Critical Uncertainties	
# of outcomes for each uncertainty	Qualitative description of each outcome

Building scenarios from the critical uncertainties – historical steps

1. Describe Critical Uncertainties

# of outcomes for each uncertainty	Qualitative description of each outcome

2. Combine Critical Uncertainties into Scenarios

Reasonable plotlines	Extremes

Building scenarios from the critical uncertainties – current status

1. Describe Critical Uncertainties

# of outcomes for each uncertainty	Qualitative description of each outcome

2. Combine Critical Uncertainties into Scenarios

Reasonable plotlines	Extremes

3. Create Quantitative Model Inputs & Iterate

The different critical uncertainties impact the forecast model in various ways

Critical Uncertainty	Forecast Model Levers
Economic Growth - Account Growth as Proxy	- Residential building stock - Commercial accounts - Industrial accounts
Natural Gas Price	- Long run natural gas fuel share

The different critical uncertainties impact the forecast model in various ways

Critical Uncertainty	Forecast Model Levers
Carbon Price	- Long run natural gas fuel share
Non-Price Carbon Policy - Building Codes - Appliance Standards - Fuel Switching Requirements	- Long run natural gas fuel share - Natural gas use per customer - Appliance efficiency

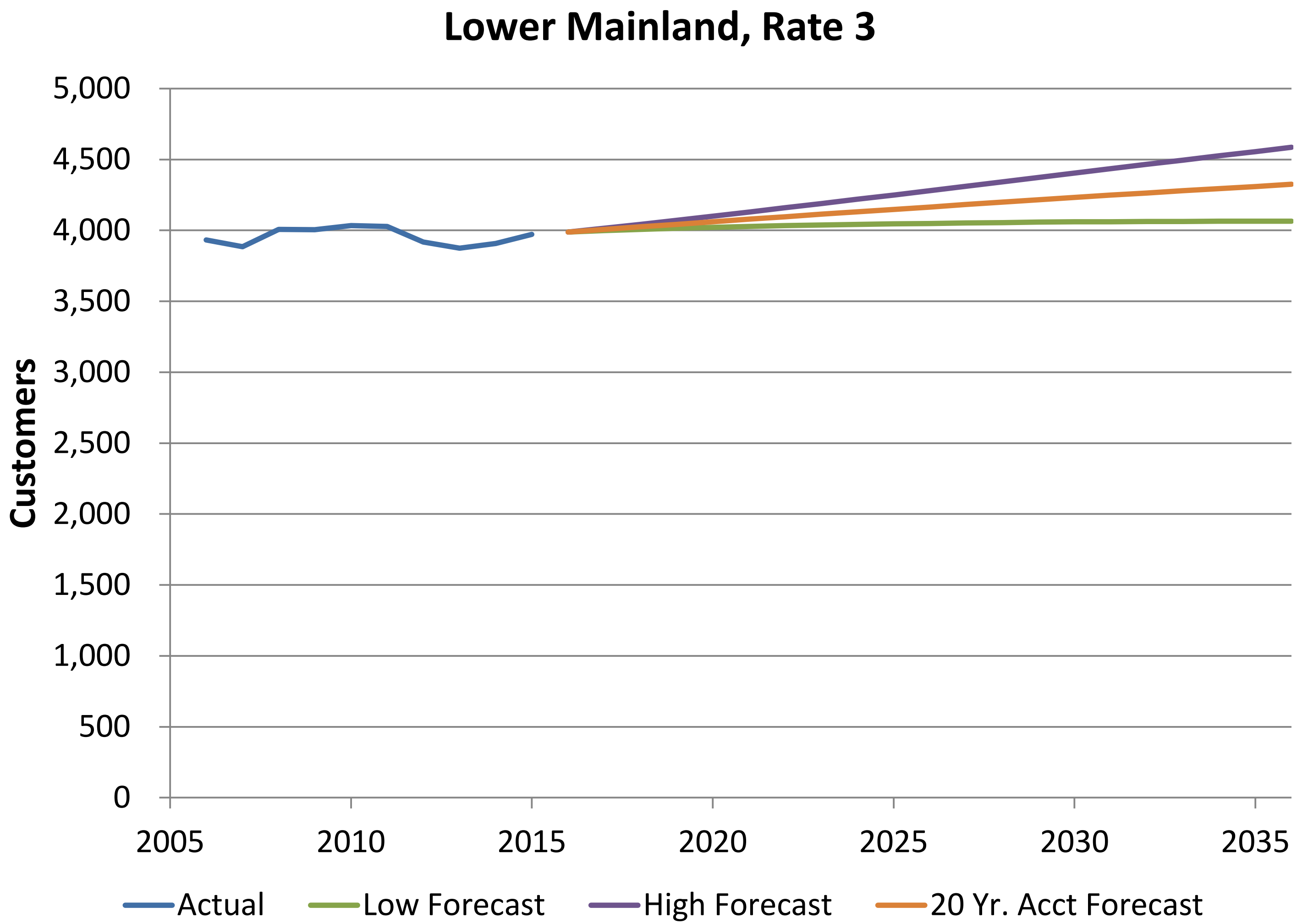
The different critical uncertainties impact the forecast model in various ways

Critical Uncertainty	Forecast Model Levers
RNG Demand - Discrete Forecast from RNG Team	- RNG fuel share
NGT Demand - Discrete Forecast from NGT Group	- Commercial & industrial rate class demand
Large Industrial Point Loads - From Internal Working Group - Layered on top of Scenario Results	- Layered on top of scenario analysis as industrial rate class demand

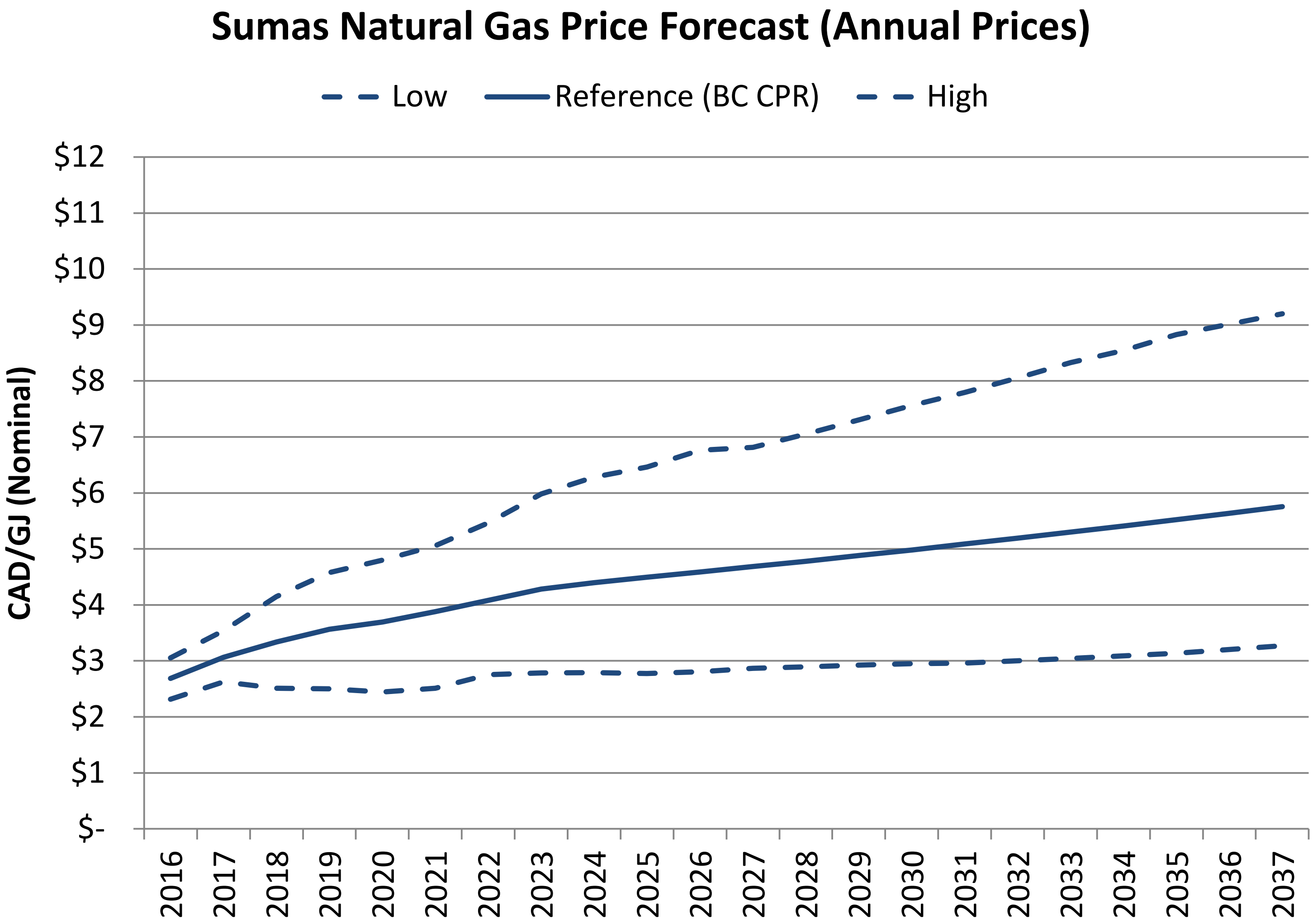
Reviewing the quantitative outcomes – economic critical uncertainties

Critical Uncertainty	Possible Outcomes
Economic Growth - Account Growth as Proxy	- High - **Reference** - Low
Natural Gas Price	- High - **Reference** - Low

Economic critical uncertainties – economic growth



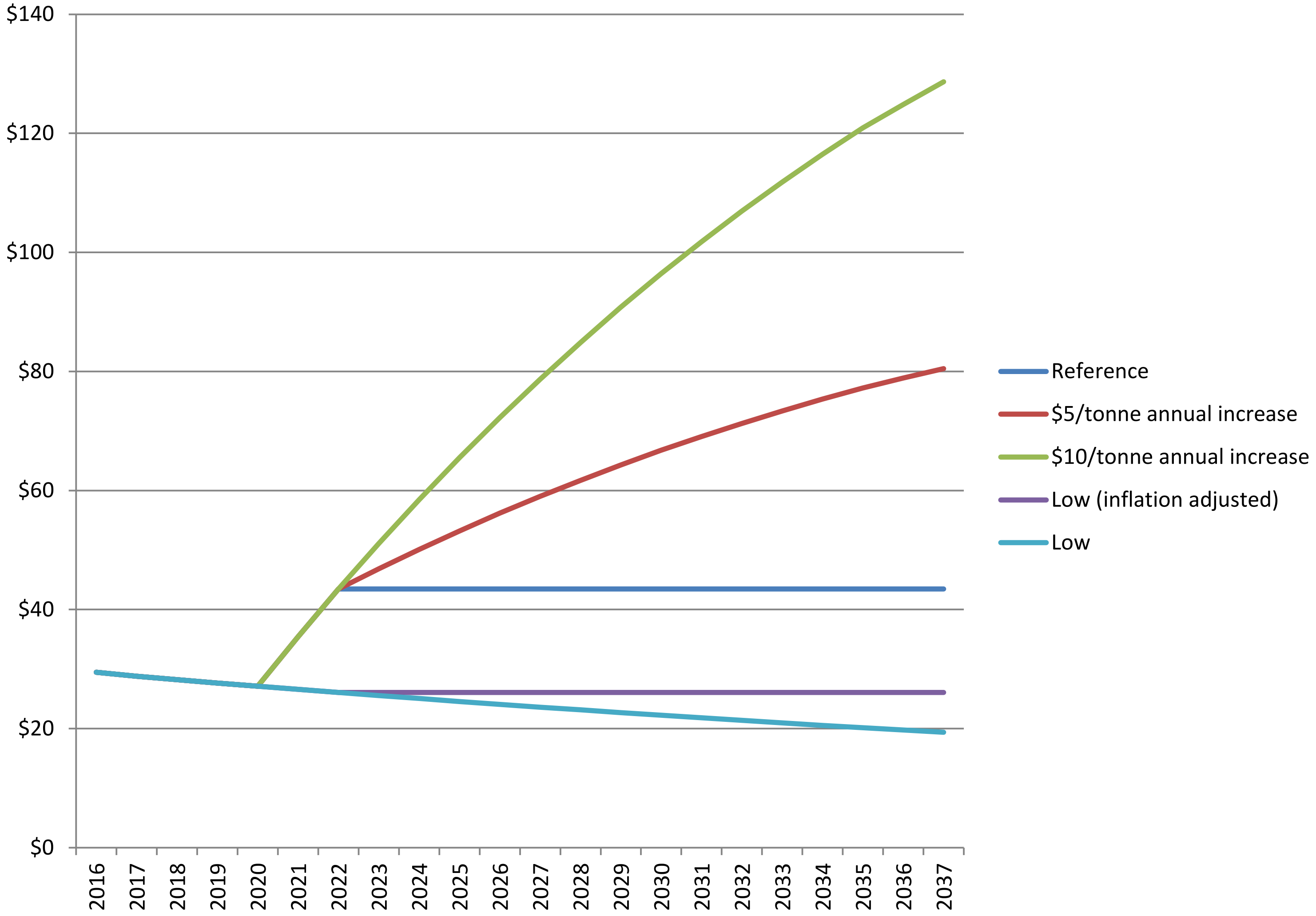
Economic critical uncertainties – natural gas price



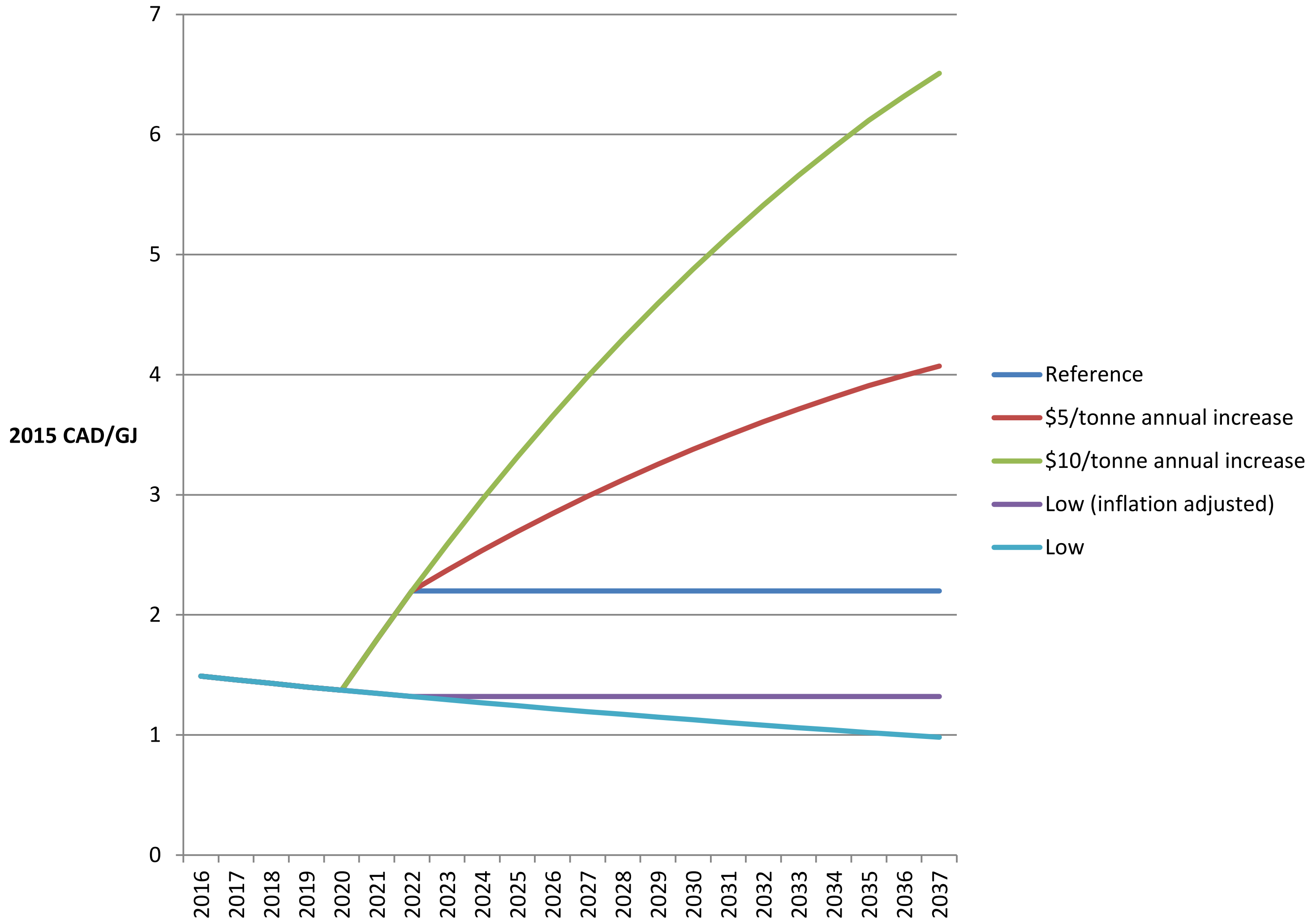
Reviewing the quantitative outcomes – carbon policy critical uncertainties

Critical Uncertainty	Possible Outcomes
Carbon Price	- High - Medium - **Reference** - Low
Non-Price Carbon Policy - Building Codes - Appliance Standards - Fuel Switching Requirements	- Accelerated - **Reference** - Delayed

Policy critical uncertainties – carbon price

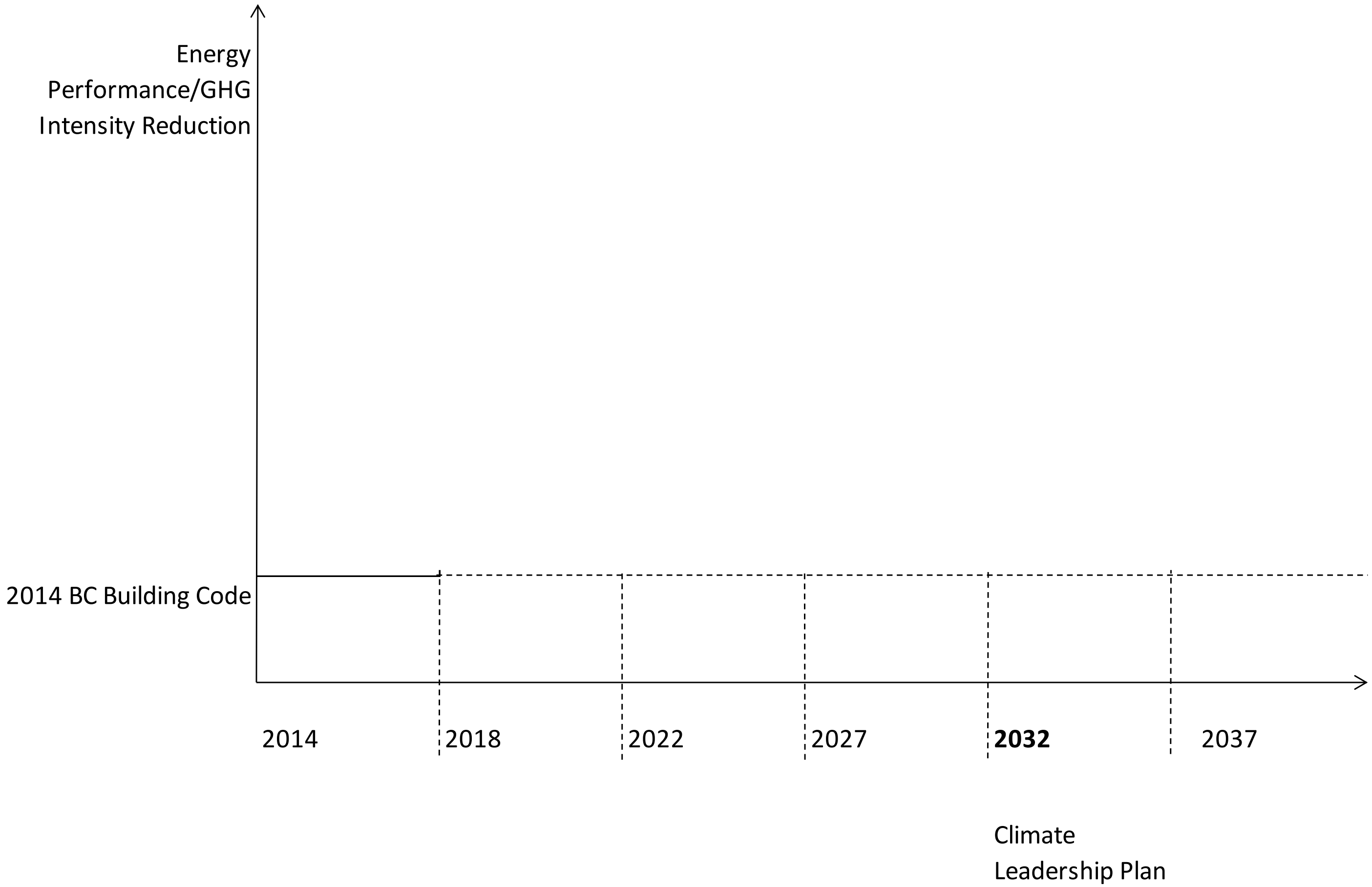


Policy critical uncertainties – carbon price



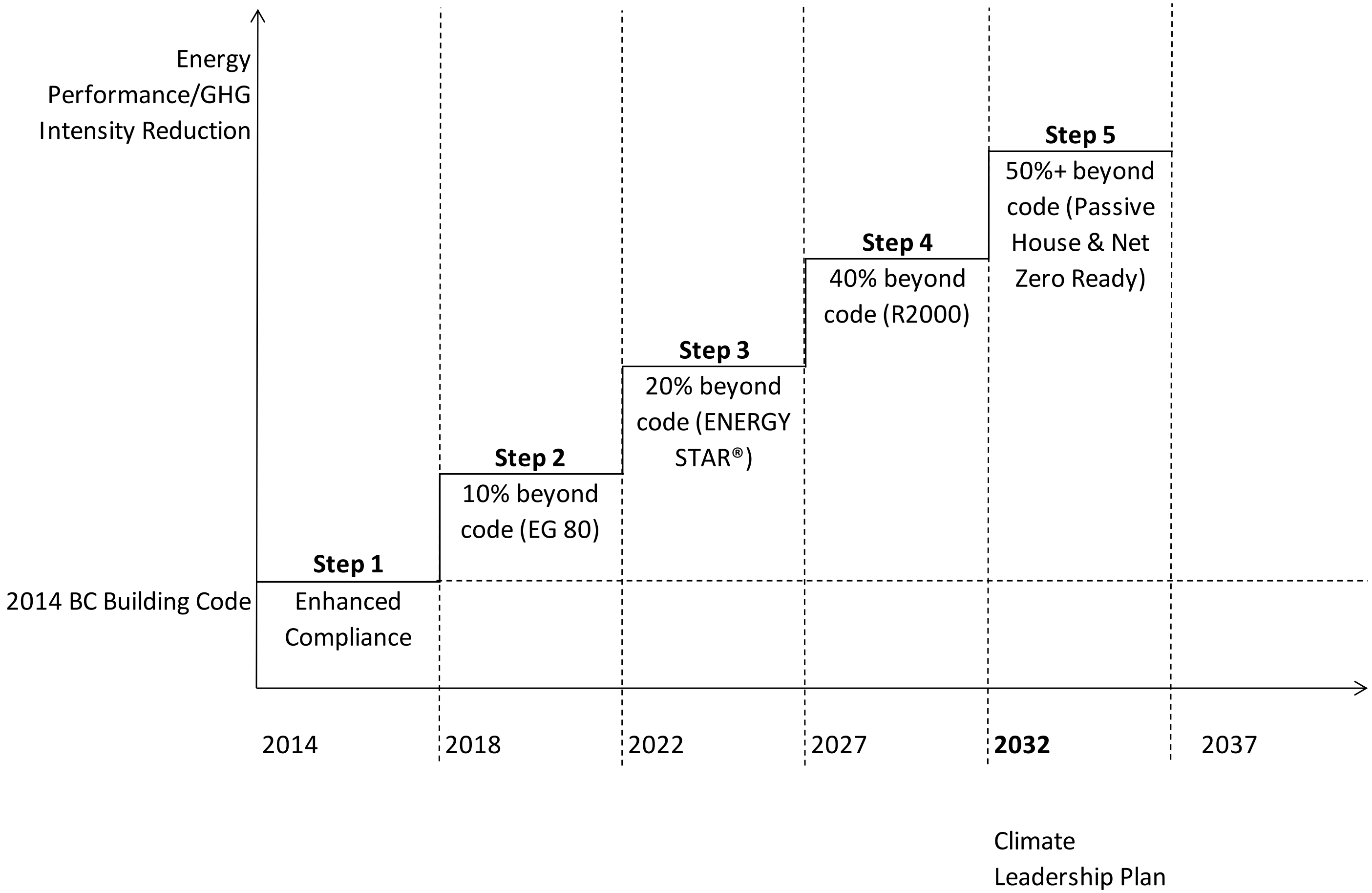
Policy critical uncertainties – building codes reference case

Illustration – Residential, Single Family Dwellings, LM



Policy critical uncertainties – building codes accelerated policy

Illustration – Residential, Single Family Dwellings, LM



Policy critical uncertainties – fuel switching for accelerated policy scenarios

Sector	Shift from Natural Gas to other fuels over 2017 LTGRP Forecast Horizon
Residential (including apartments)	- 26%-36% reduction for space heating - 16%-25% reduction for domestic hot water
Commercial	- 15.17% of buildings connect to district energy systems - Additional 1.56% of buildings switch hot water loads away from natural gas
Industrial	- 1.04% of buildings switch hot water loads away from natural gas

Policy critical uncertainties – appliance standards for <u>accelerated policy scenarios</u>

Sector	Assumed Performance Standards
Residential	- **Fireplaces:** minimum 50% FE in 2018 - **Furnaces:** minimum 95% AFUE in 2020 - **Boilers:** minimum 90% AFUE in 2020 and 95% AFUE in 2025 - **Tankless water heaters:** minimum 82% EF in 2018
Commercial	- **Water heaters:** minimum 95% TE in 2018
Industrial	- N/A

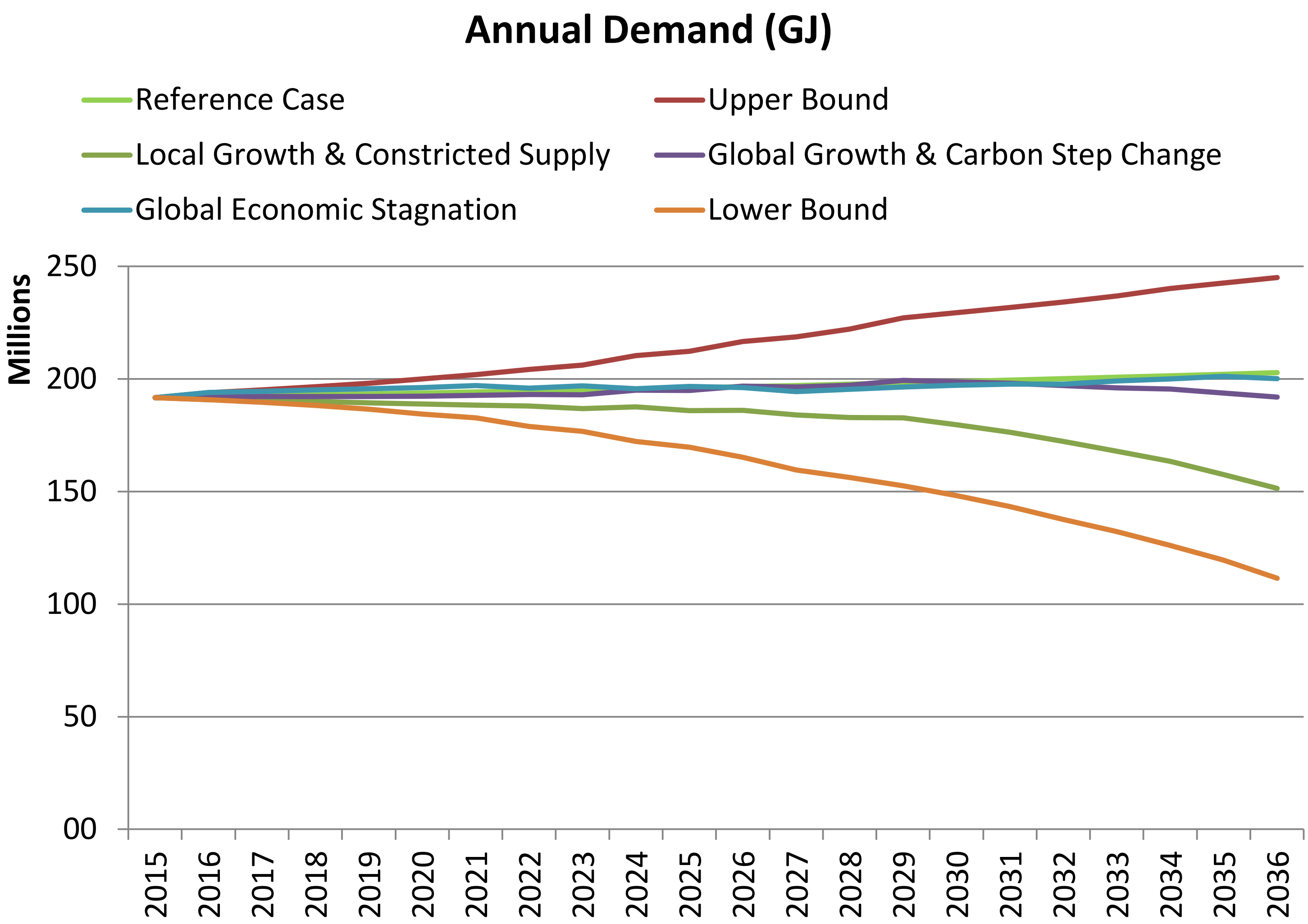
Reviewing the quantitative outcomes – extraneous critical uncertainties

Critical Uncertainty	Possible Outcomes
RNG Demand - Discrete Forecast from RNG Team	- High - **Reference** - Low
NGT Demand - Discrete Forecast from NGT Group	- High - **Reference** - Low
Large Industrial Point Loads - From Internal Working Group - Layered on top of Scenario Results	- **Reference** - Hypothetical examples

Any questions about assumptions before we proceed to results?

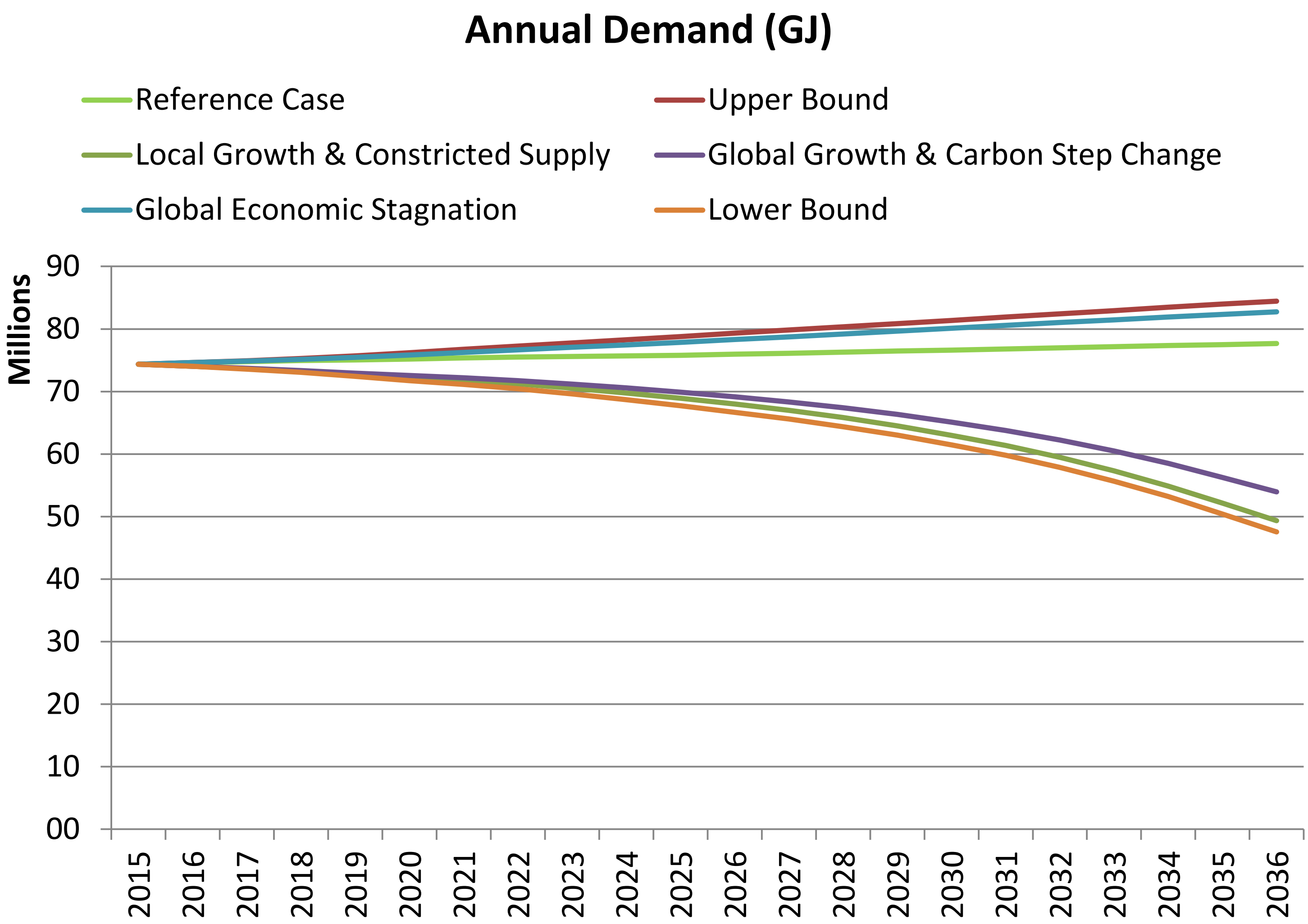
Please refer to the scenario summary handouts on your desks.

Width of the forecast jaws – all sectors

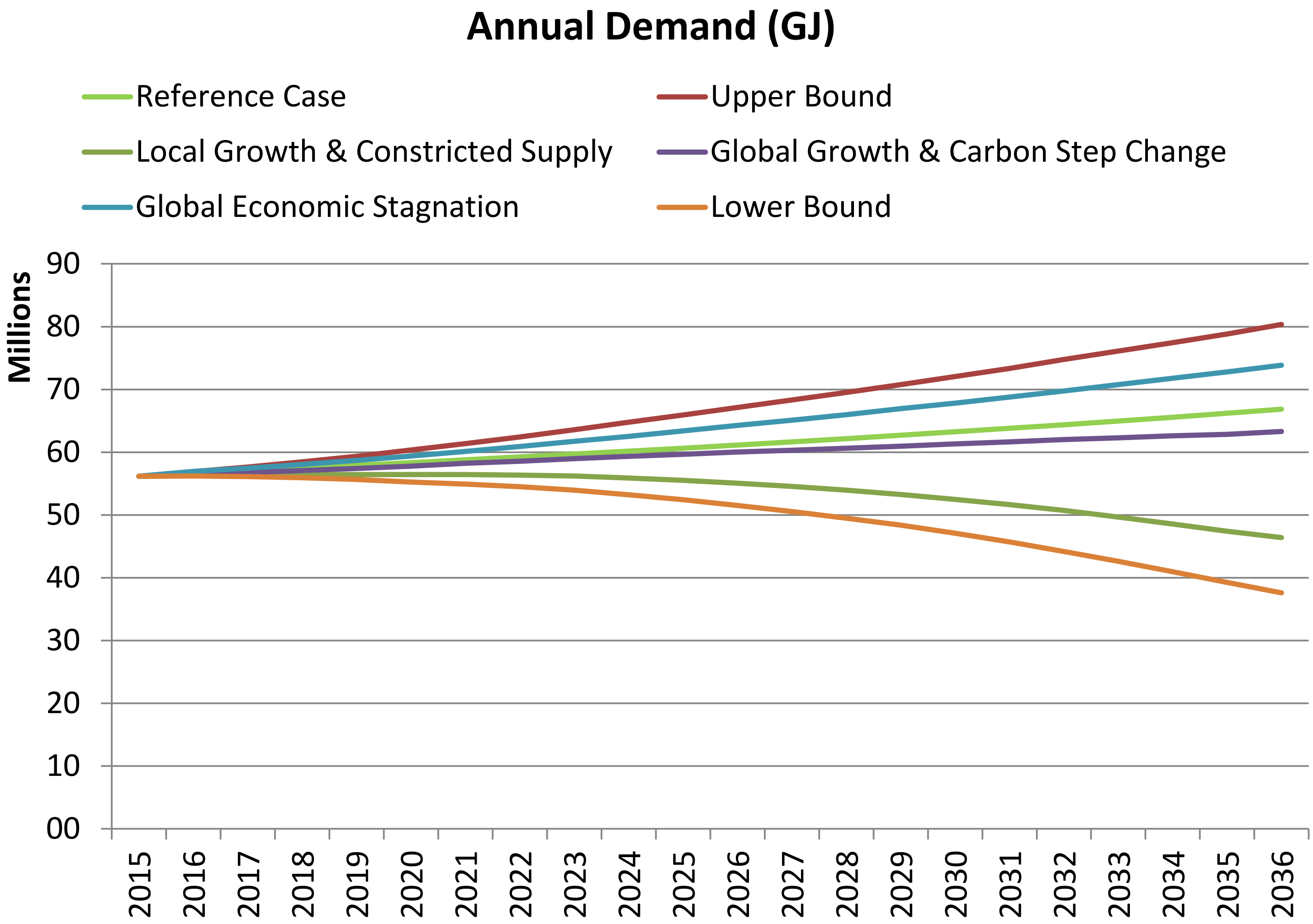


N.B.: TPT-1 and TPT-2 as well as all company own use demand are excluded from all results.

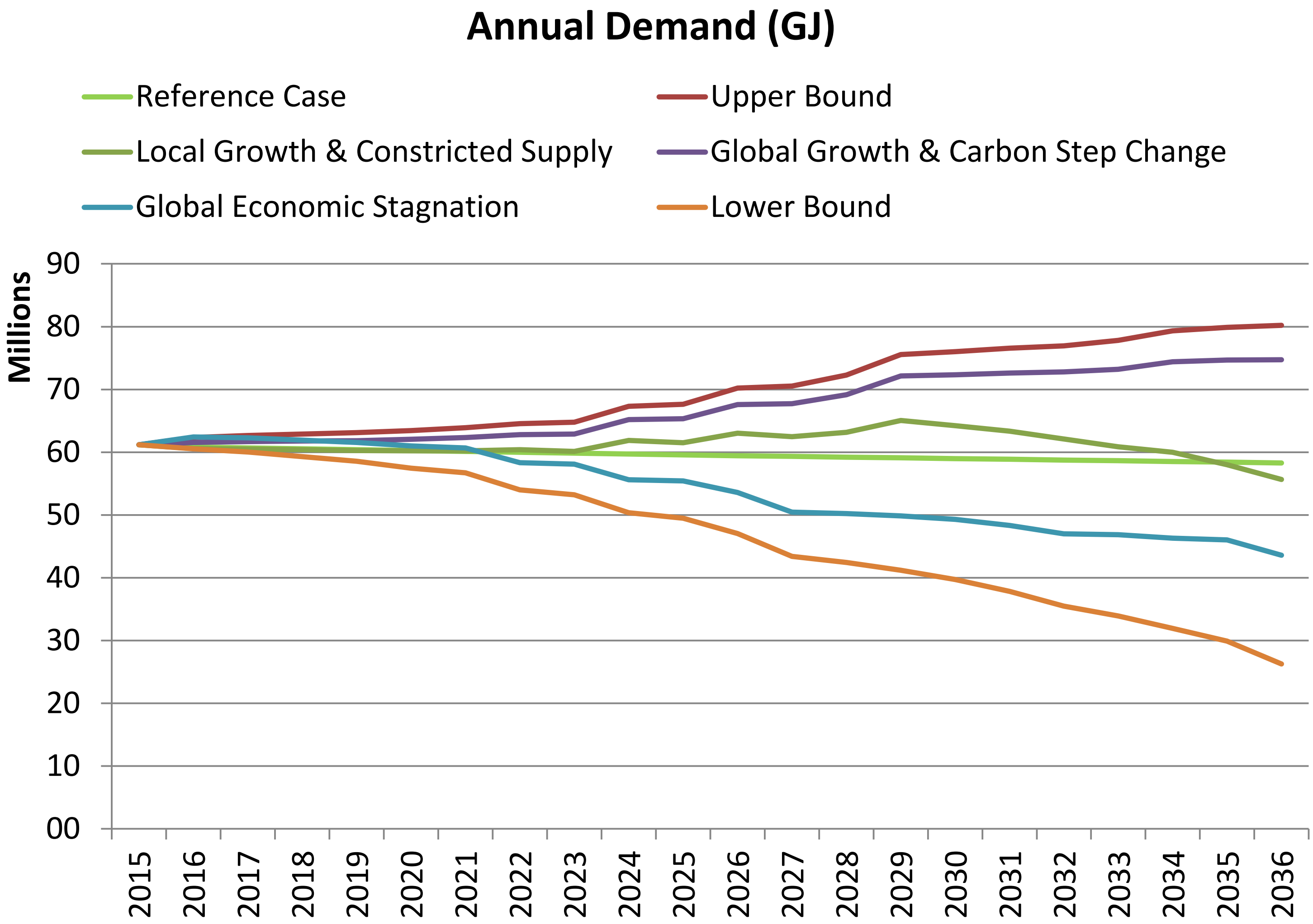
Detailed scenario results – residential



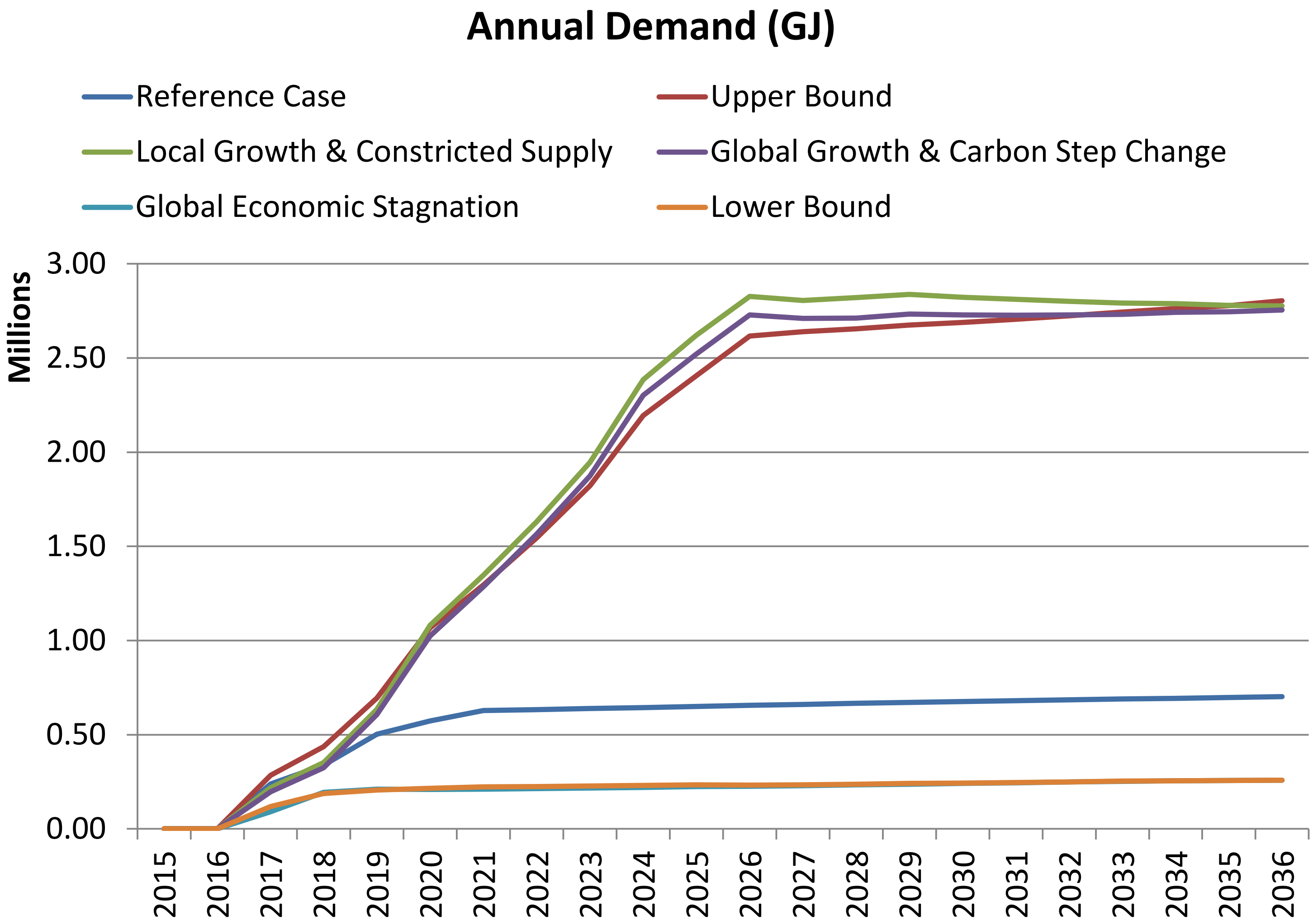
Detailed scenario results – commercial



Detailed scenario results – industrial



Detailed scenario results – Renewable Natural Gas



Any scenario questions before we conclude this section?

Introduction & objectives

Feedback from Workshop 1

Annual Demand Reference Case

Scenario Analysis Review

System Capacity Planning

Wrap-Up & Next Steps

Energy at work

FORTIS BC™

System Capacity Planning

In the next hour we will discuss…

- Annual demand versus peak demand.
- Differences in peak demand for system capacity planning and gas supply planning
- Traditional peak demand method – System Capacity Planning
- Posterity Group's pilot study to derive peak day and peak hour UPC and forecasts from annual demand UPC and forecasts
- Anticipated outcomes…

Annual and Peak Demand

Annual Demand

- Determines the amount of gas FEI acquires and transports on behalf of customers on an annual basis
- Determines units of energy available to recover costs of service and rate of return

Peak Demand

- Highest demand expected on the system
- Correlated to cold weather
- Does not include seasonal and interruptible customer classes
- Peak demand estimated as the maximum consumption hourly during an unusually cold weather event
- FEI designs systems to ensure delivery of gas to all firm customers in a cold weather event that might occur once in 20 years
- 22 independent weather zone throughout FEI service areas considered in peak planning for system capacity

Peak Demand

Gas Supply vs. System Capacity

Peak Demand - Gas Supply Planning

- Determines supply resources needed to serve customers during a peak day event
- Resources for transportation customers are not included

Peak Demand – System Capacity

- Determines the infrastructure needed to deliver gas to core customers during a peak day or peak hour event
- Infrastructure requirements must also allow delivery of gas to firm transportation customers
- Location of demand within the transmission and distribution system is a significant factor

Peak Demand and Peak Forecast for System Capacity

Peak Demand (base year)

Peak Demand = Demand Rate 1,2,3 (monthly data) + Industrial Max Observed (hourly data) + Firm DTQ Contract Obligations

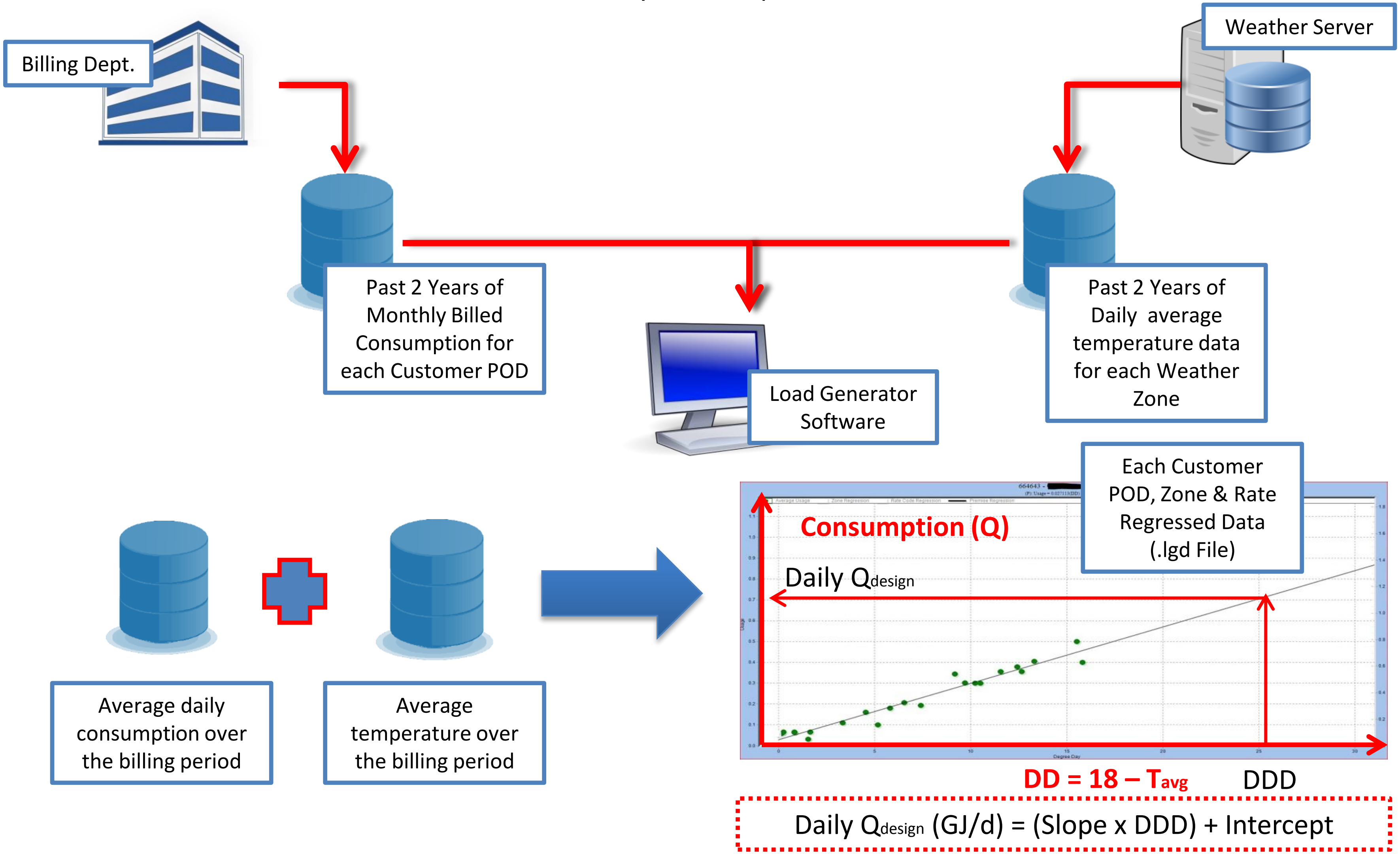
Peak Demand Forecast (traditional)

Peak Demand Year n = Demand Rate 1,2,3 + (net adds$_{\text{(year 1 to year n)}}$ x UPC$_{\text{peak}}$) + Industrial Maximum Observed + Firm DTQ Contract Obligations

UPC$_{\text{peak}}$, industrial demand and firm DTQ demand remains constant over the forecast period

How do we derive Peak Hour Load for our Hydraulic Models and Forecasts ?

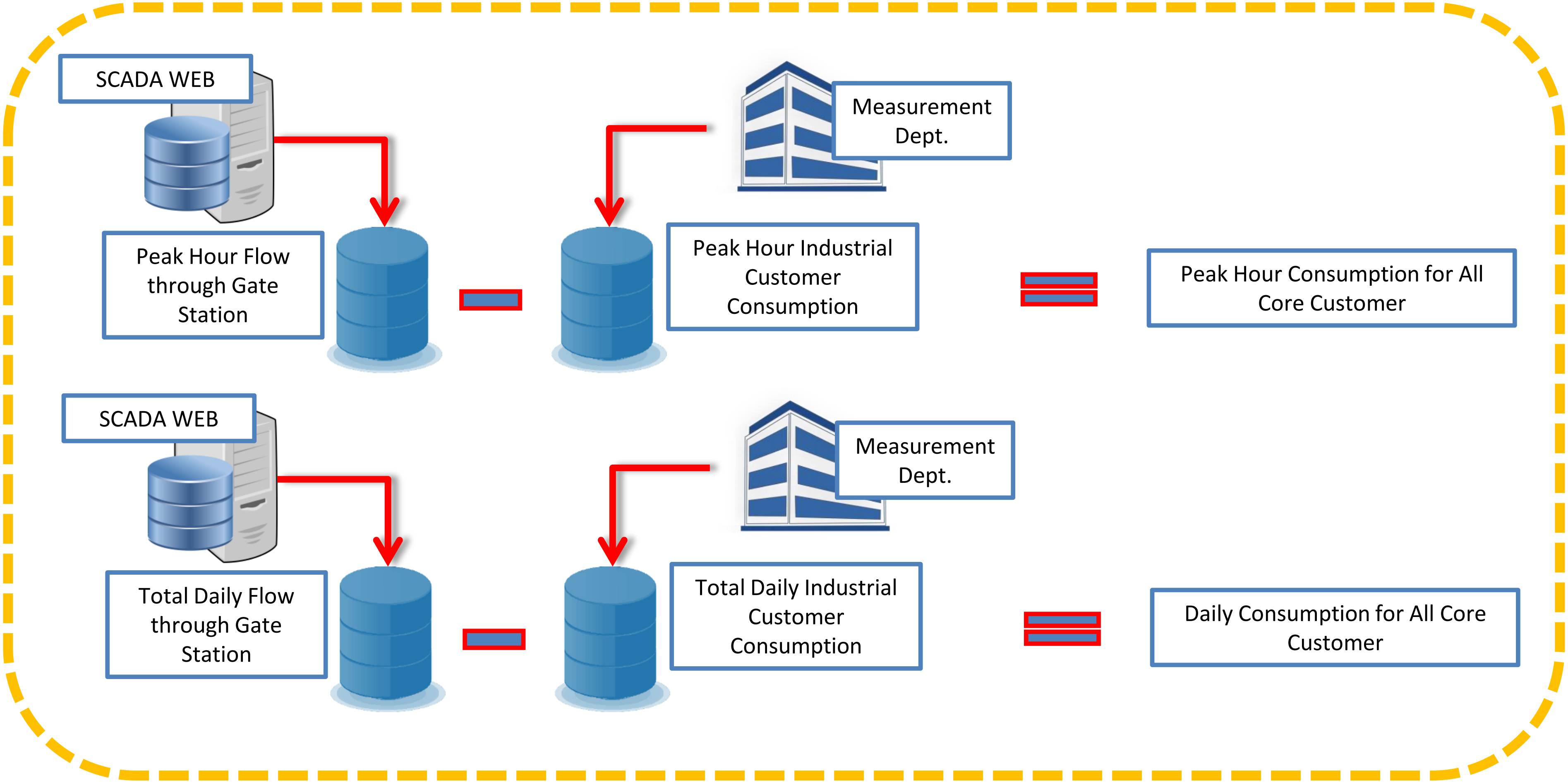
Core Rate 1, 2 & 3 Customers – Monthly consumption data



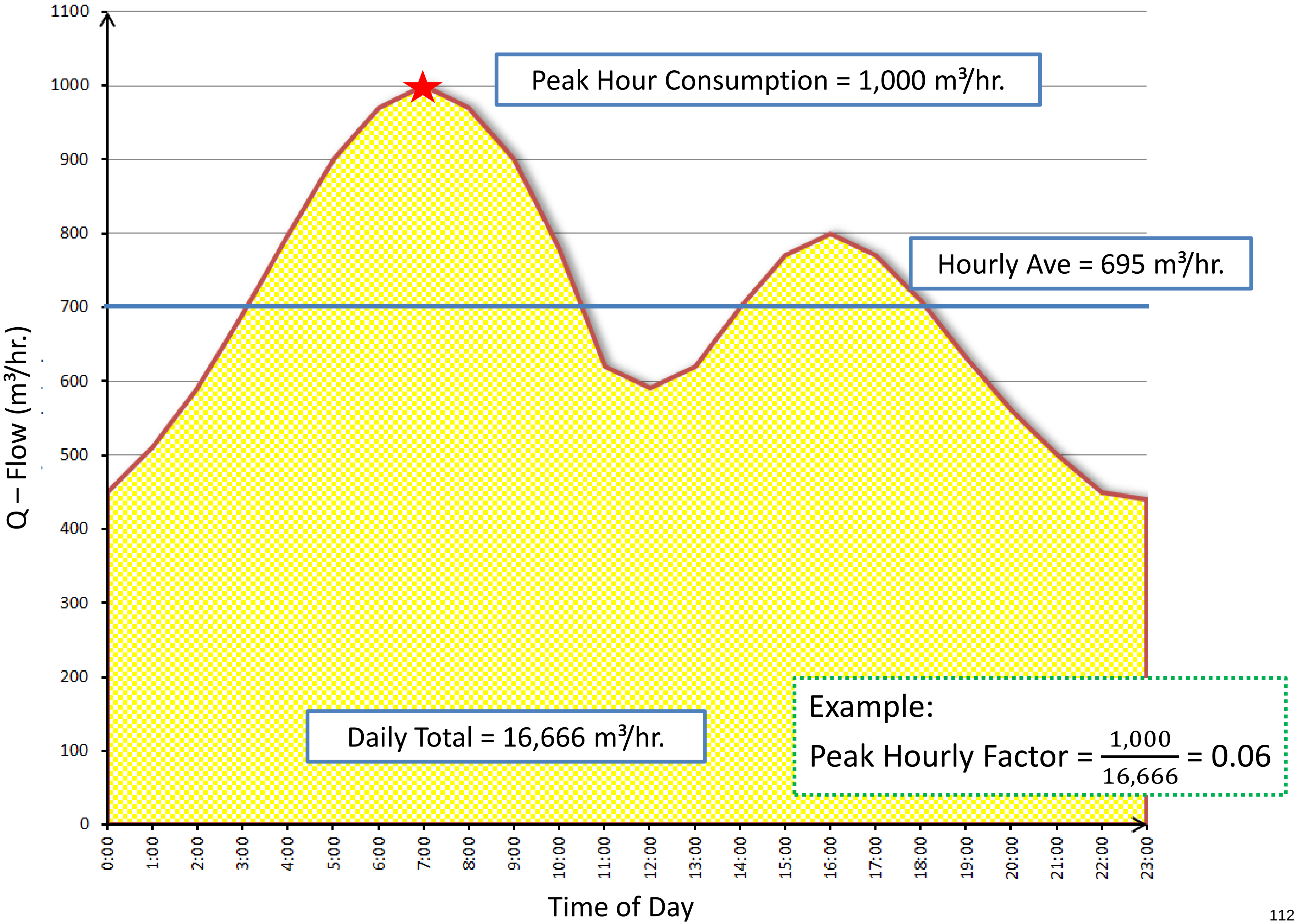
Peak Hour Factor

- Used to convert daily consumption to peak hour consumption for customers with monthly consumption data only. (Rate 1, 2 & 3 Customer)
- Peak Hour typically happen around 7am or 8am

Peak Hourly Factor = Peak Hour Consumption / Daily Consumption



continued


Peak Hour Consumption = 1,000 m³/hr.
Hourly Ave = 695 m³/hr.
Daily Total = 16,666 m³/hr.
Example:
Peak Hourly Factor = $\frac{1,000}{16,666}$ = 0.06
Q – Flow (m³/hr.)
Time of Day
0
100
200
300
400
500
600
700
800
900
1000
1100
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00

Peak Demand Method

Peak Hour Use Per Customer (Core)

- UPC_{peak}=Daily Q_{Design} x PHF/HV

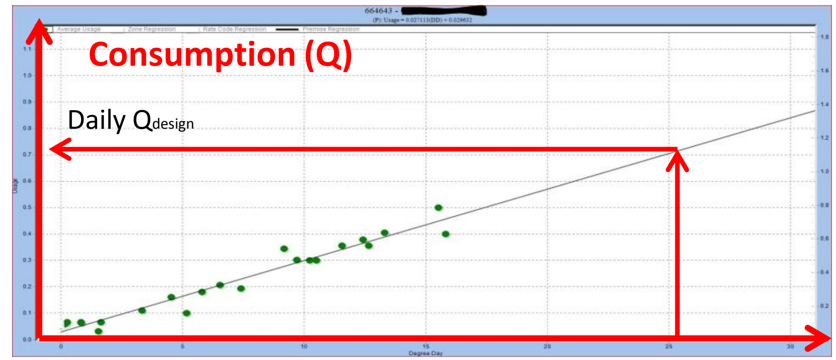
  HV = Heating Value (GJ/std m^3)

Heating value converts energy demand into the equivalent standard volume used for hydraulic modeling

- Average UPC_{peak} values for each region and for each rate class (1,2 & 3) are determined

- Regional UPC_{peak} values are averaged with the results of the previous two years analysis to smooth any atypical changes in UPC_{peak} that don't sustain year over year

- The resulting 3 year rolling average UPC_{peak} values are used in modeling and forecasting



DD = 18 – T_{avg} **DDD**

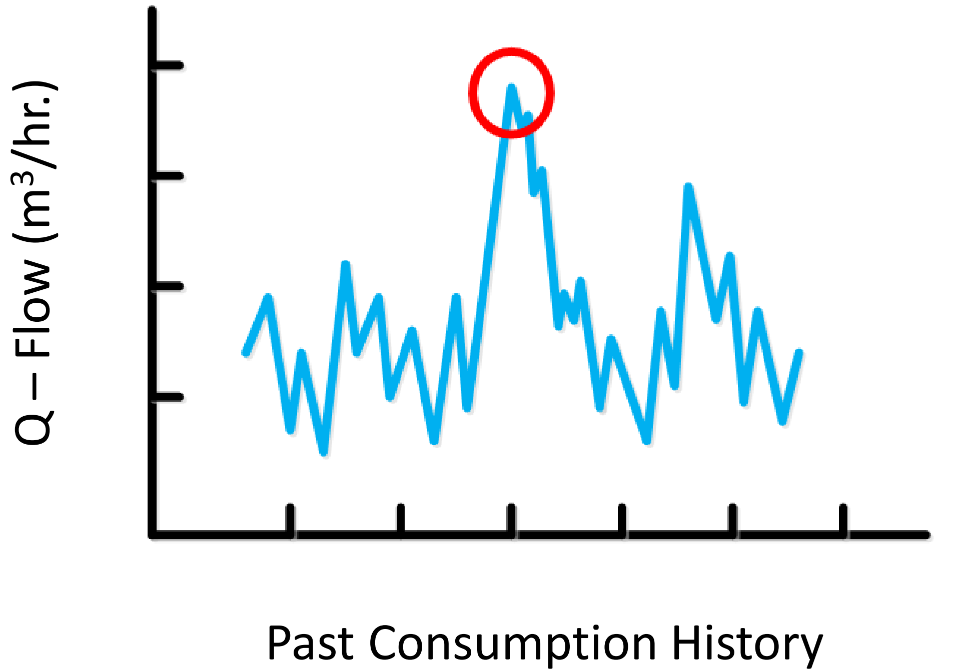
Daily Q_{design} (GJ/d) = (Slope x DDD) + Intercept

DDD = Design Degree Day

Peak Demand Method

Industrial Customers – Hourly measurement

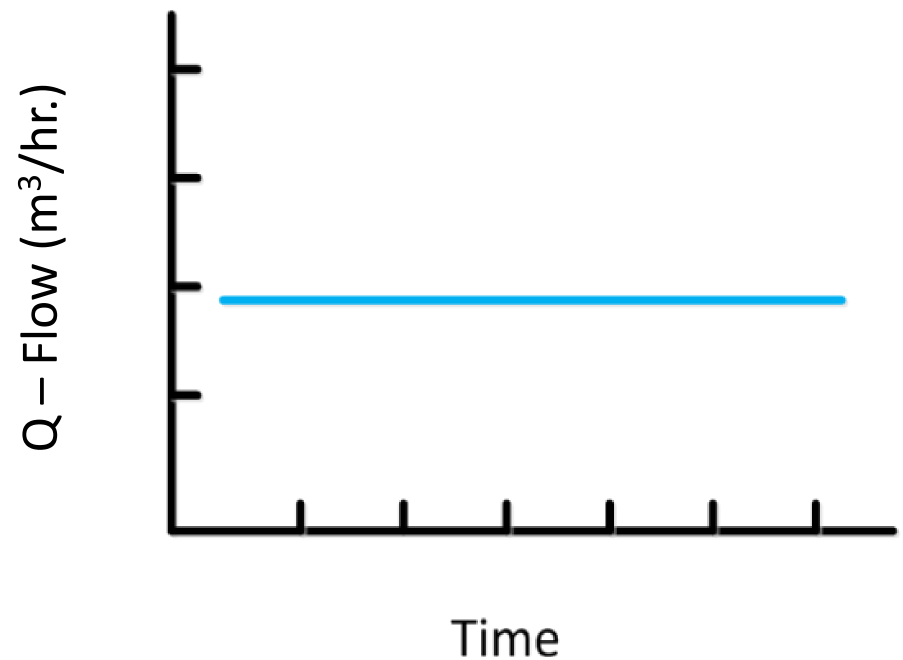
- For process (non weather sensitive loads) the maximum observed hourly demand is used
- For weather sensitive demand a temperature regressed value is used
- No peak hour factor is applied



Peak Demand Method

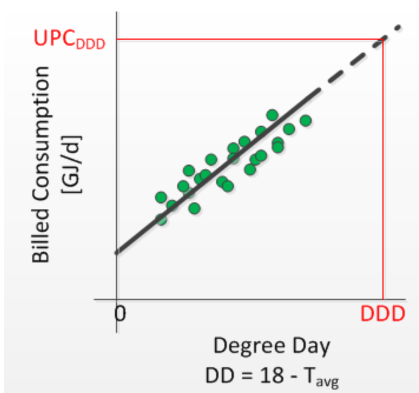
Customers with contract firm– Contract DTQ obligations

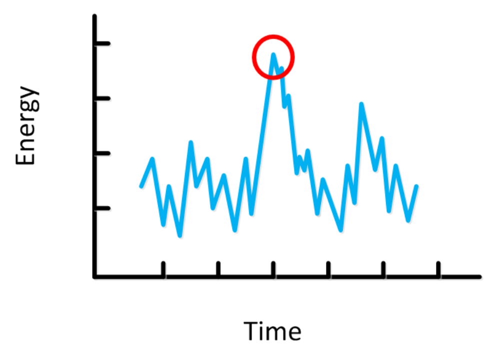
- Large interruptible transportation customers may have a firm contract amount
- These customers are limited to 5% of their firm daily total quantity (DTQ) under peak hour conditions

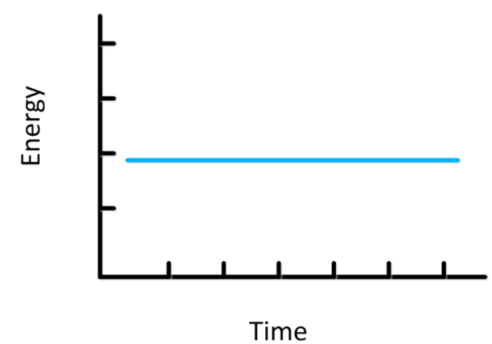


Peak Demand Method

Peak Demand = Demand Rate 1,2,3 + Industrial Maximum Observed + Firm DTQ Contract Obligations

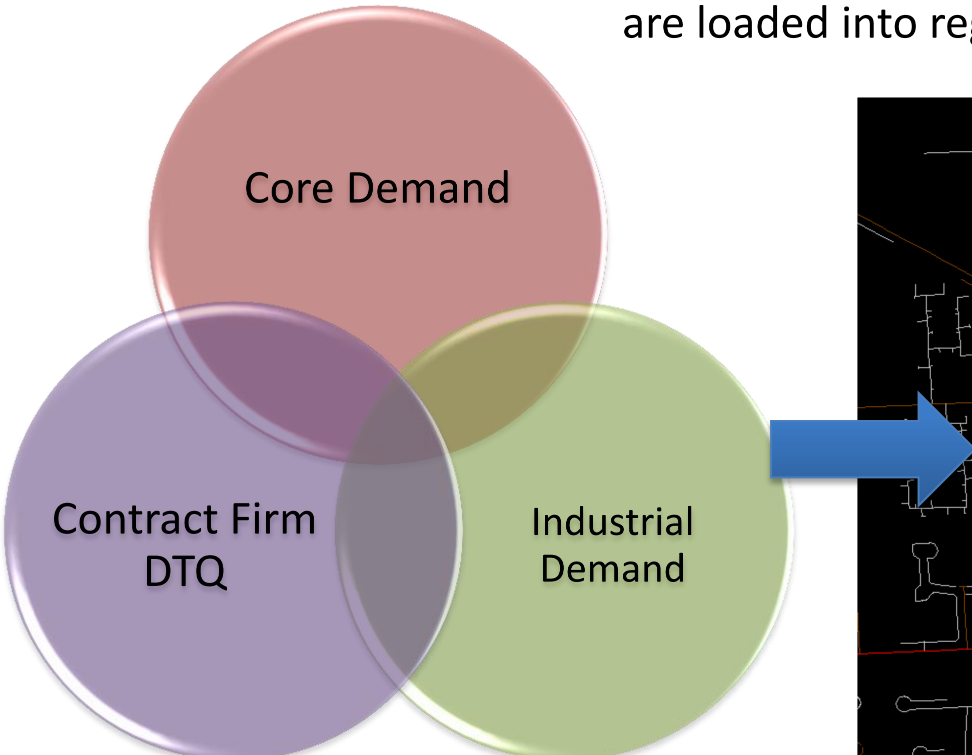


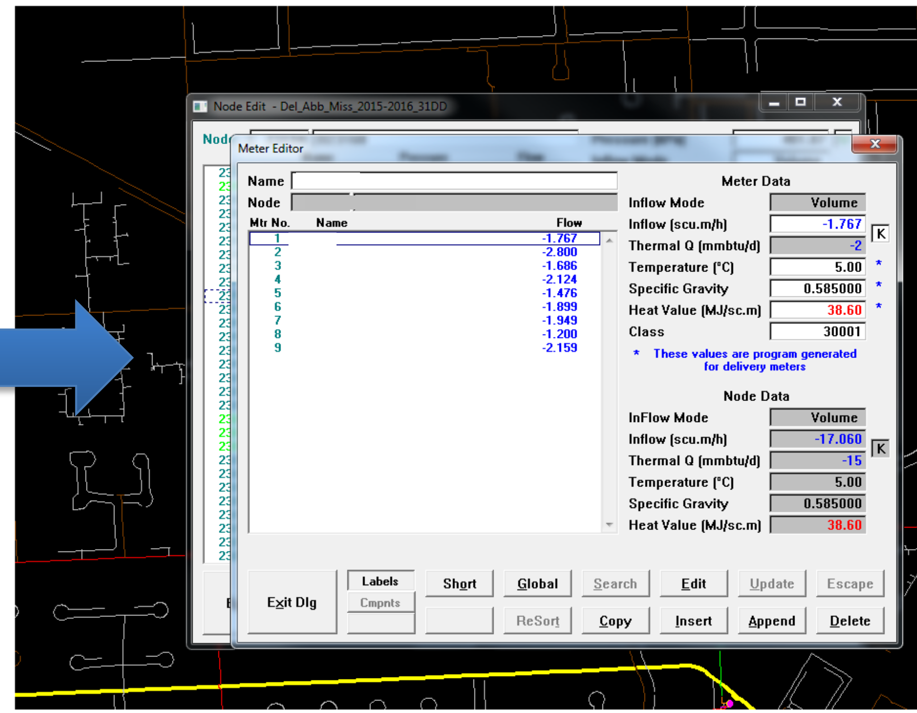




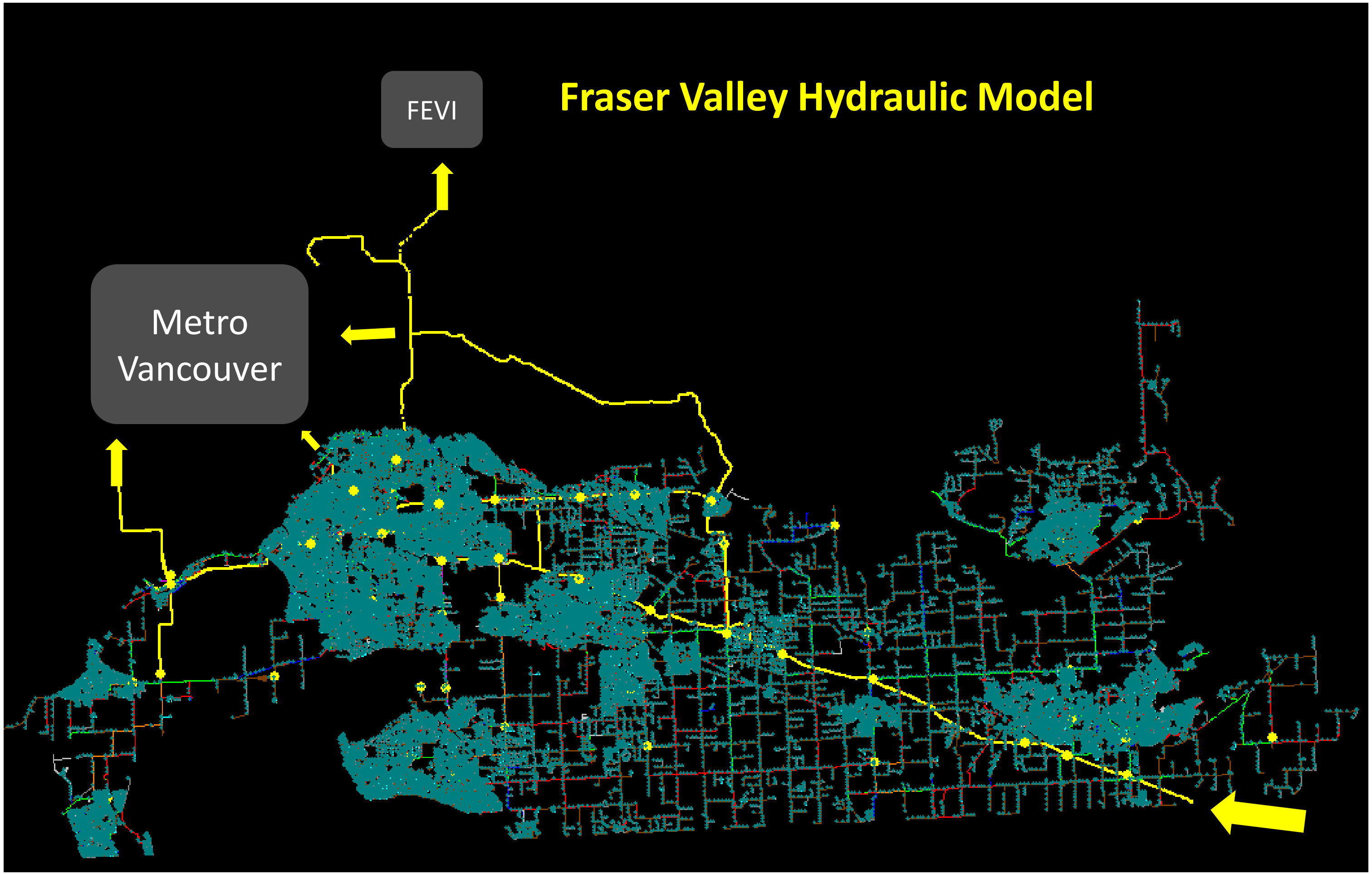
Peak Demand Method

Current assessments of customer peak demand are loaded into regional hydraulic models.





Peak Demand Method



Gas System Reinforcements

Peak Demand = Existing System Capacity

Compression

Pipelines

LNG Peaking Storage Facilities

Peak Demand Forecast

Traditionally…

- Base year peak demand for core customers is determined as previously described
- The current UPC_{peak} values are applied new customers over the planning period

(added peak consumption = $\sum$customer adds x UPC_{peak})

- The current industrial account and firm DTQ contract account numbers are held constant with no increase or decrease in peak consumption

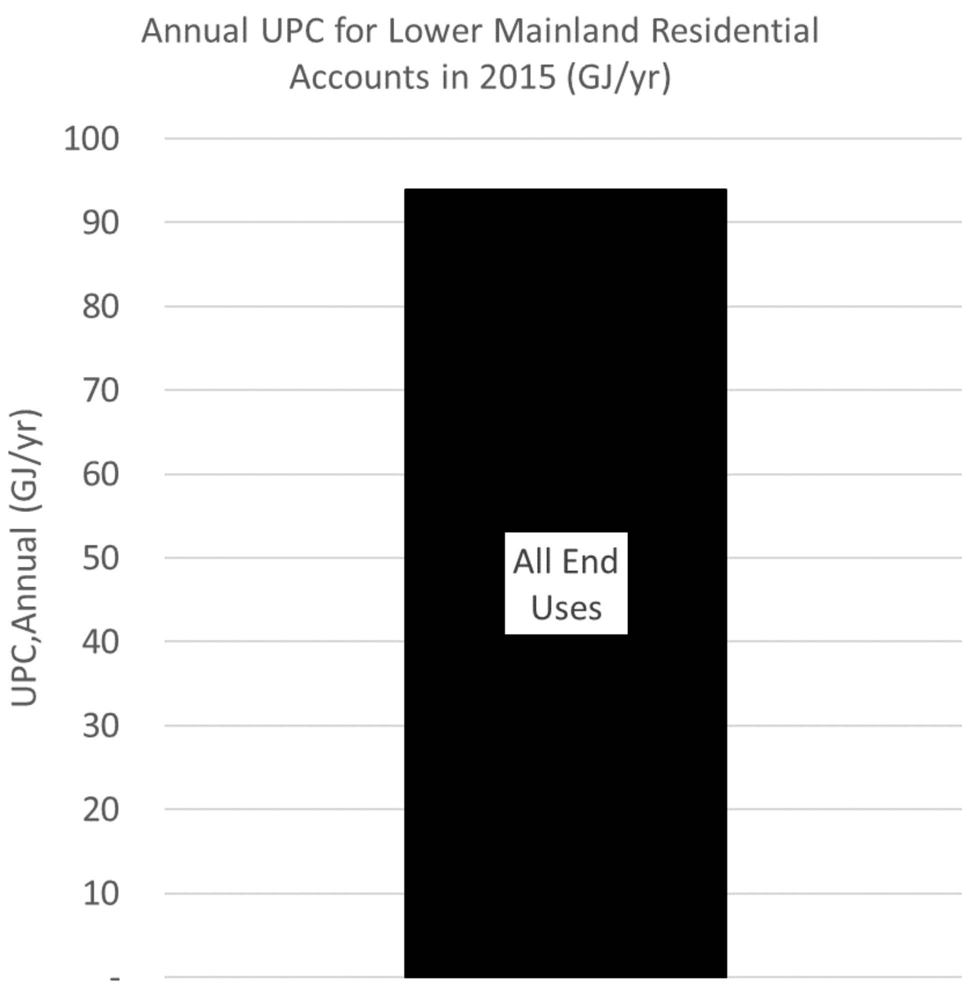
Peak Demand Forecast

Examining alternatives to the traditional method…

- Base year peak demand for core customers is determined as previously described.
- The UPC_{peak} values for existing and new customers core and industrial customers are varied over the planning period.
- UPC_{peak} variations will be derived considering the same end use factors used to determine annual demand in each scenario.
- Industrial accounts will vary in the high and low forecasts.

FortisBC Known Values

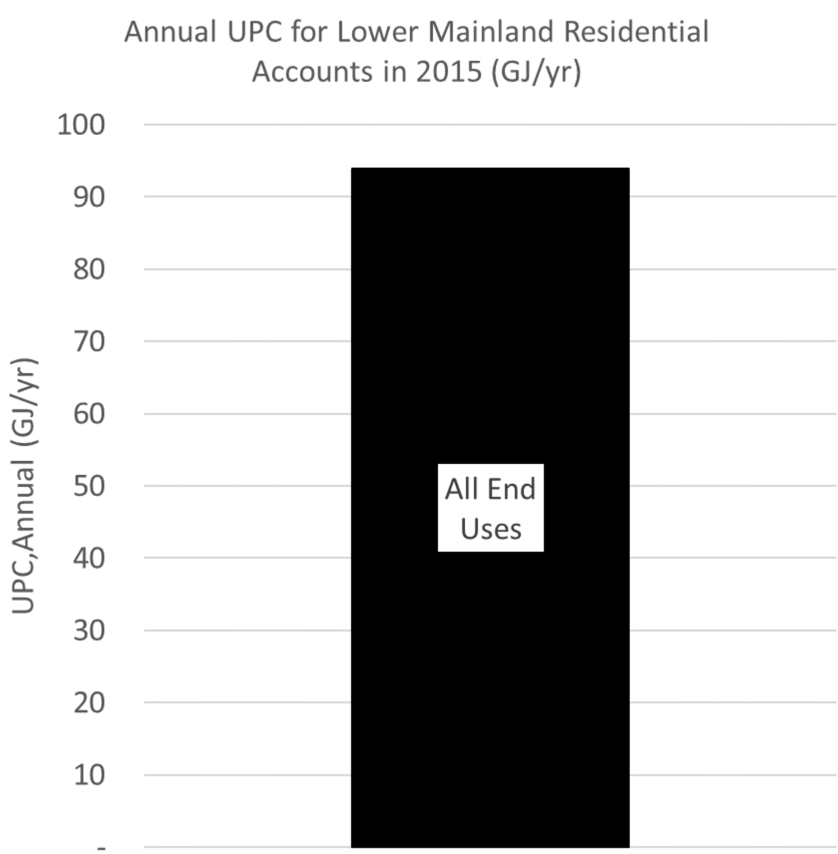
From customer sales data



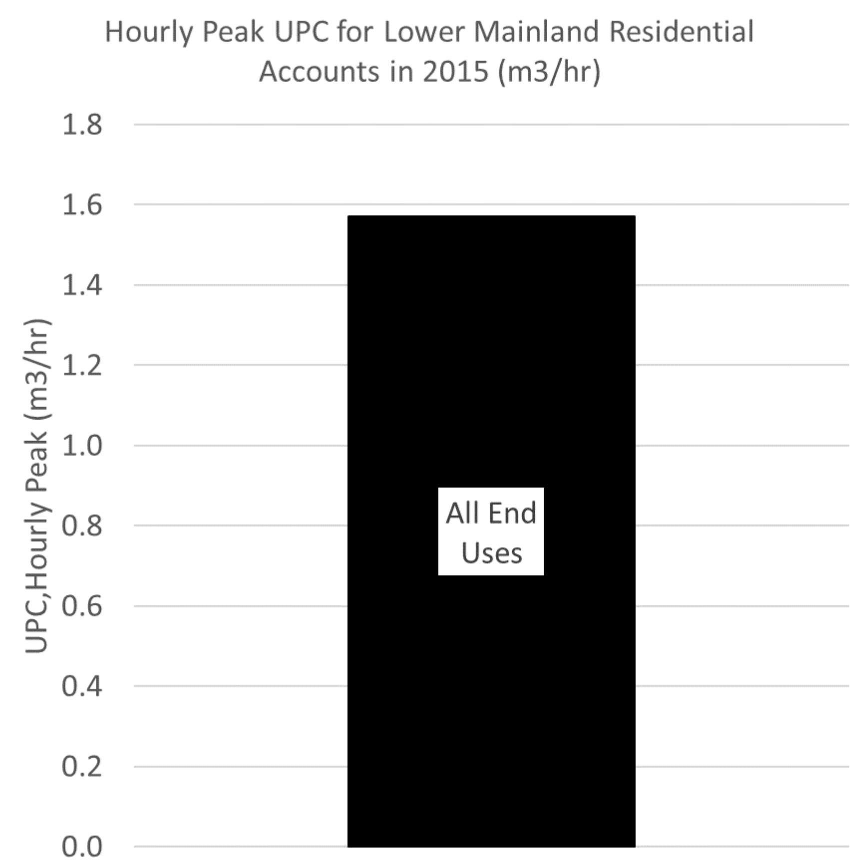
FortisBC Known Values

POSTERITY GROUP

From customer sales data

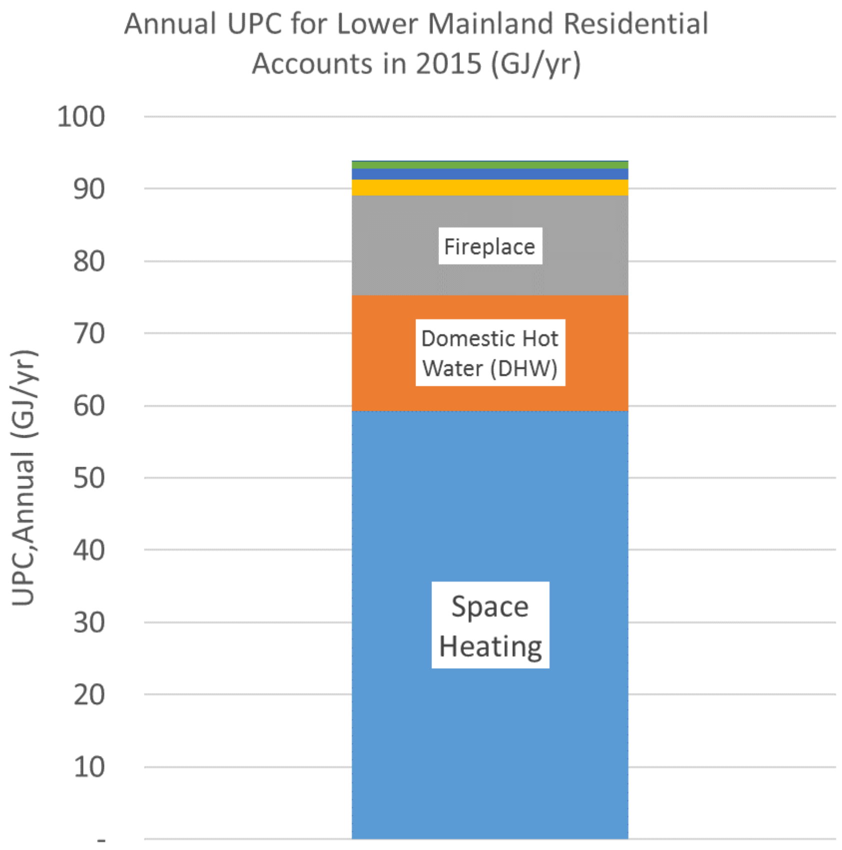


From system planning data

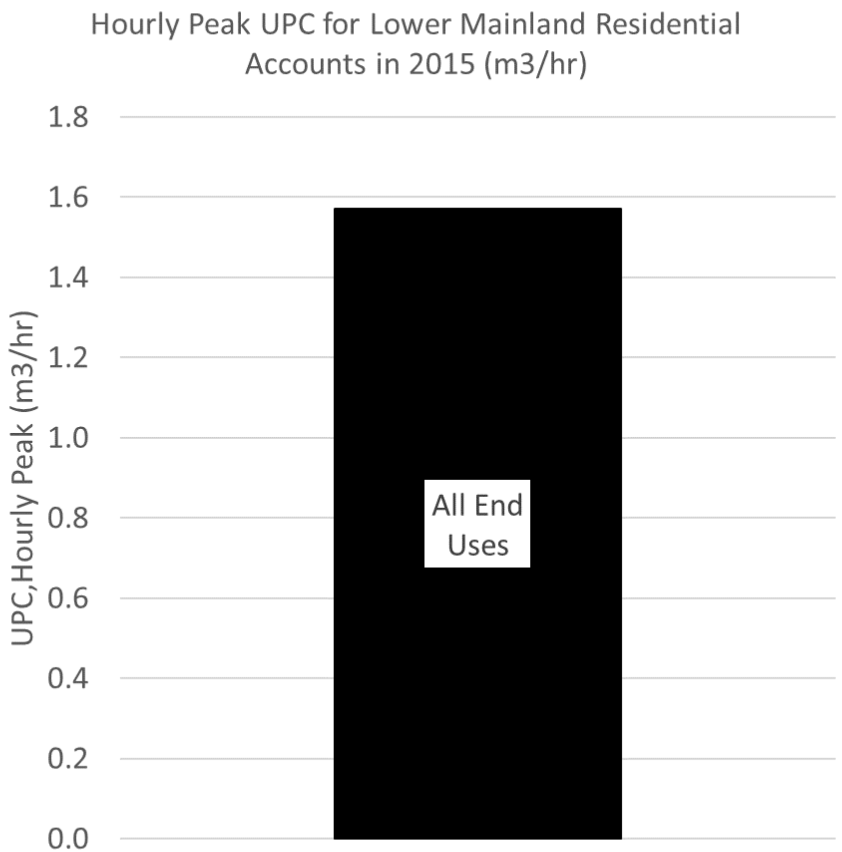


Adding End-Use Value

From End Use Model

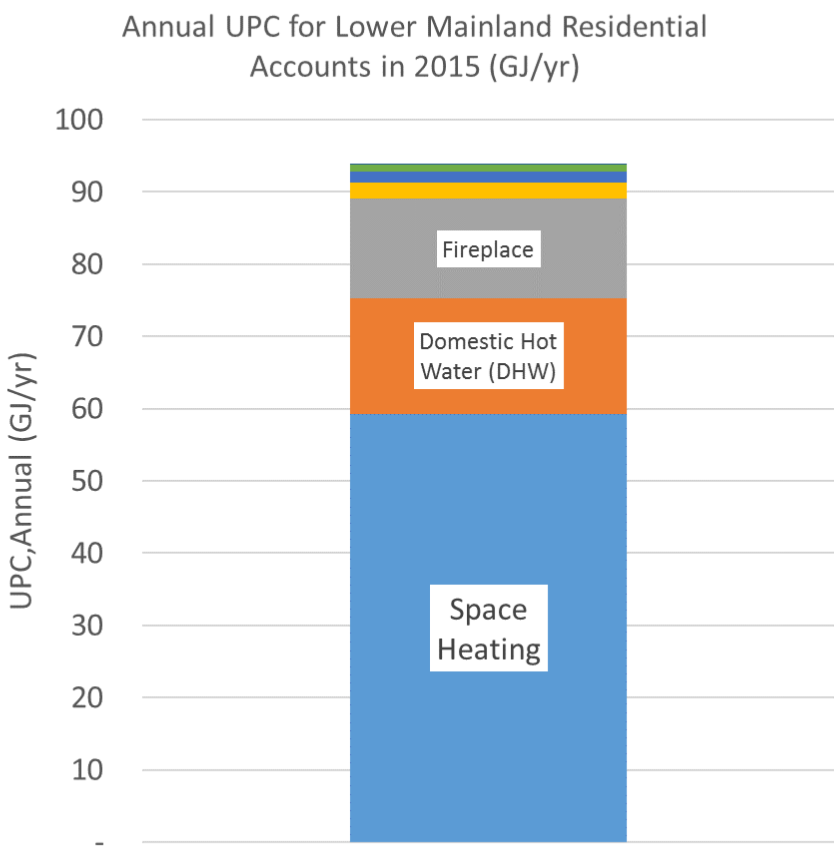


From system planning data

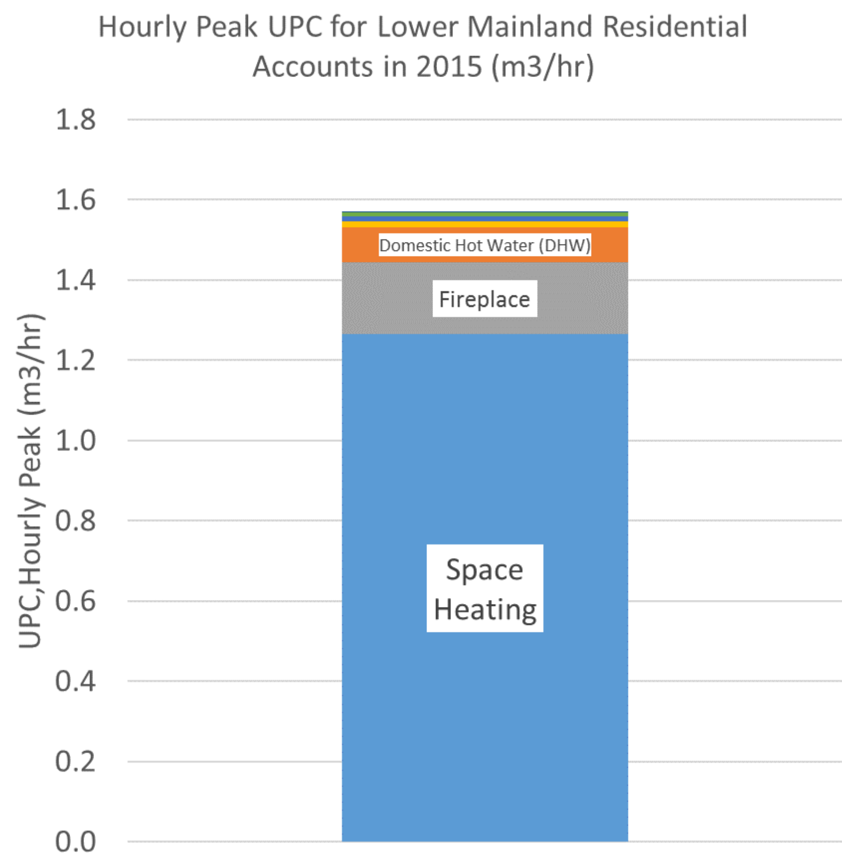


Adding End-Use Value

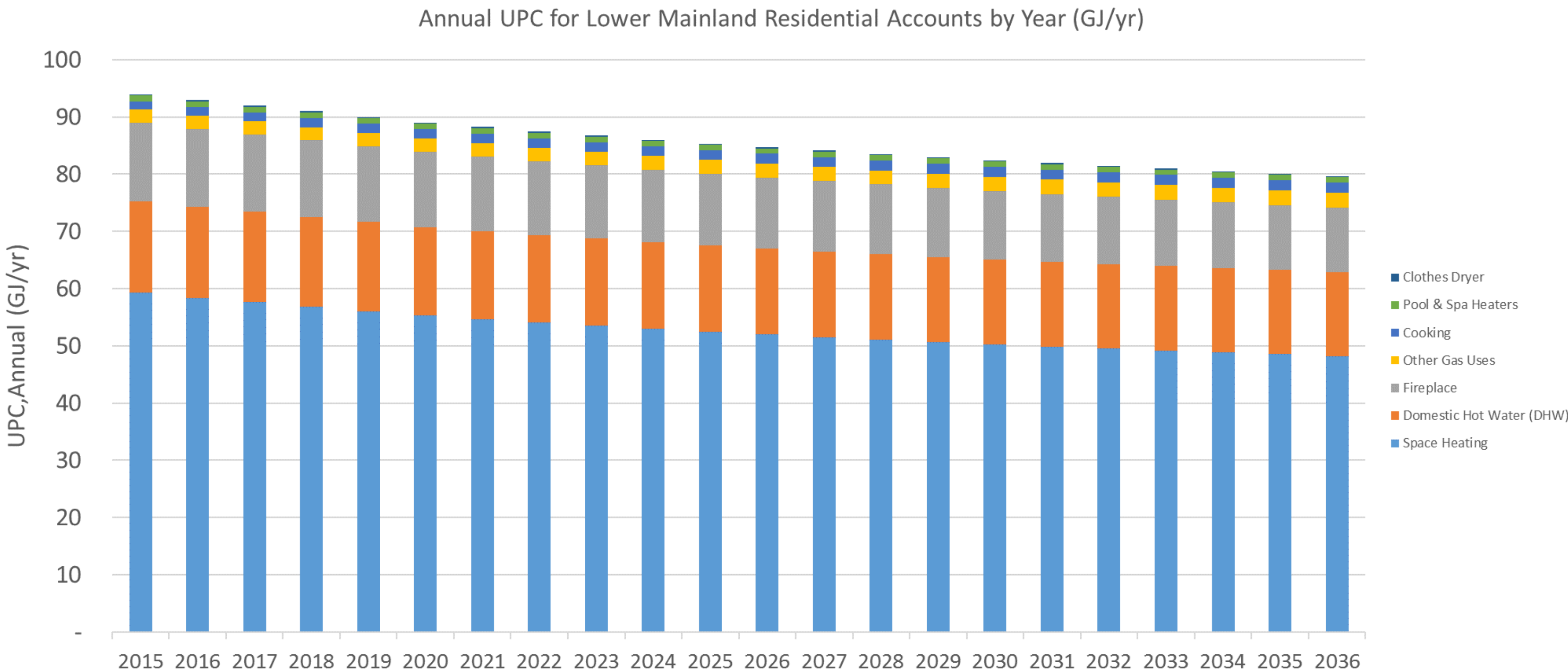
From End Use Model



From Load Shape Model

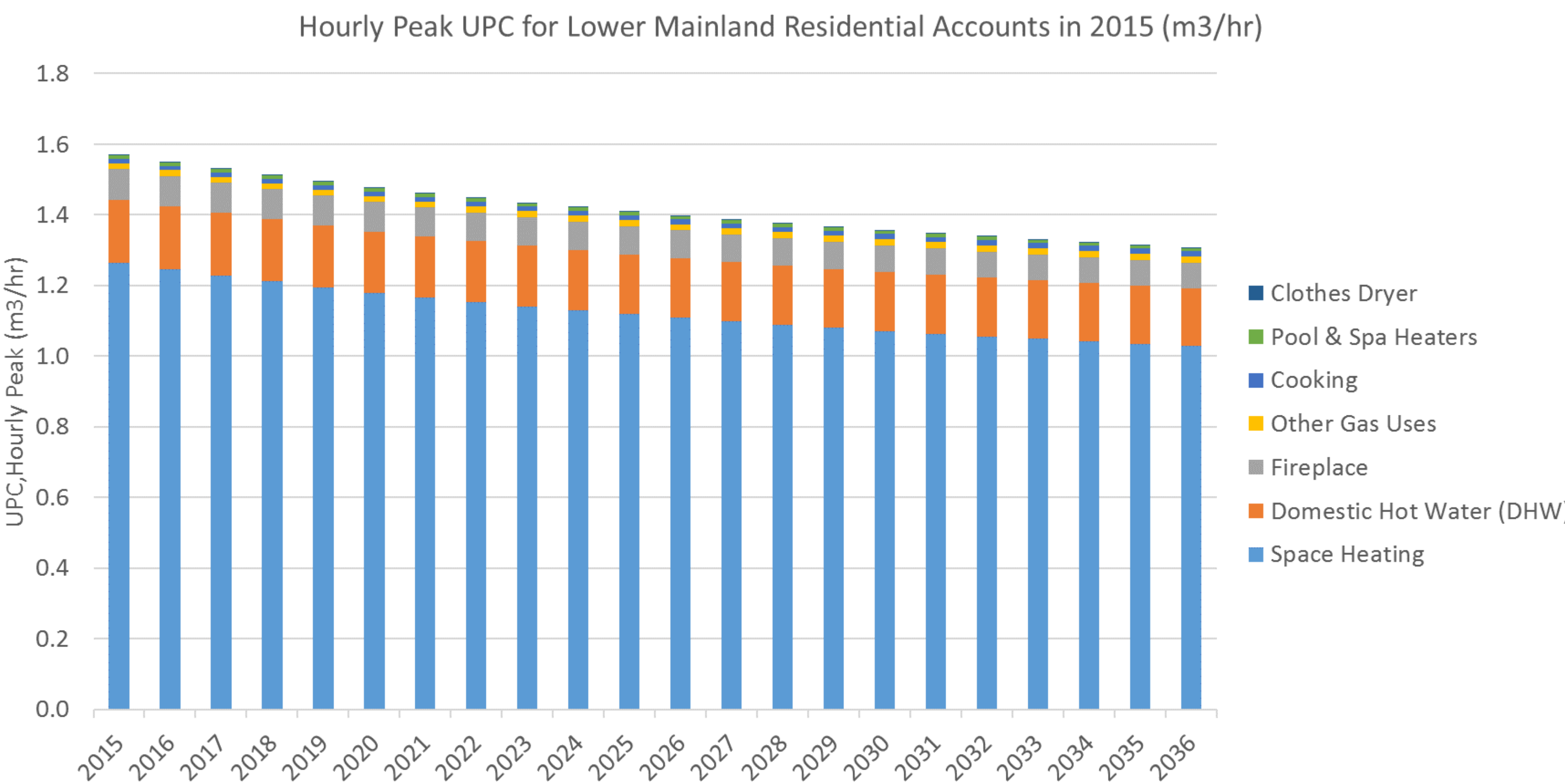


Reference Case Forecast - Annual



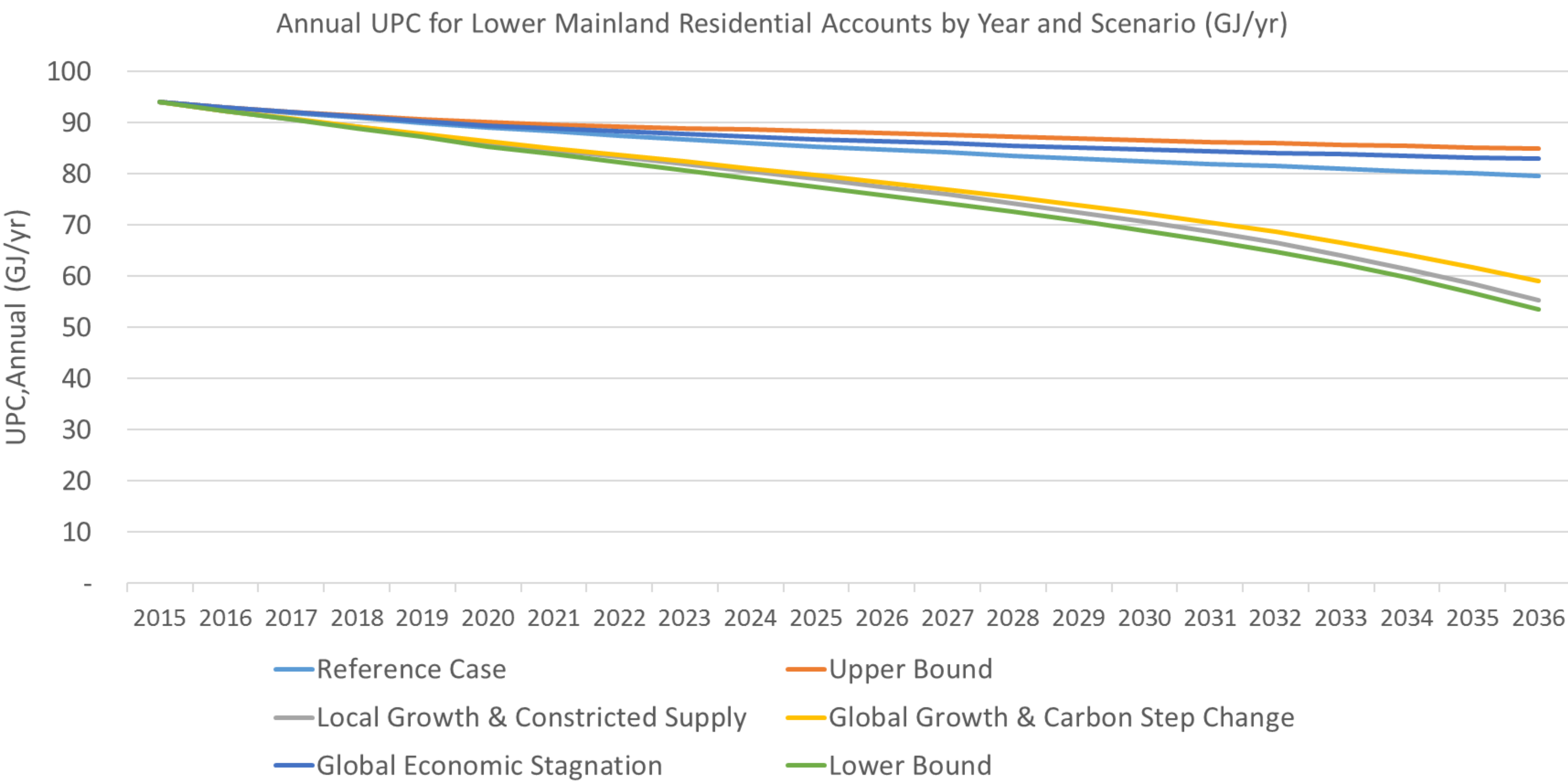
Reference forecast projects a decline in annual UPC of approximately 15%.

Reference Case Forecast - Peak



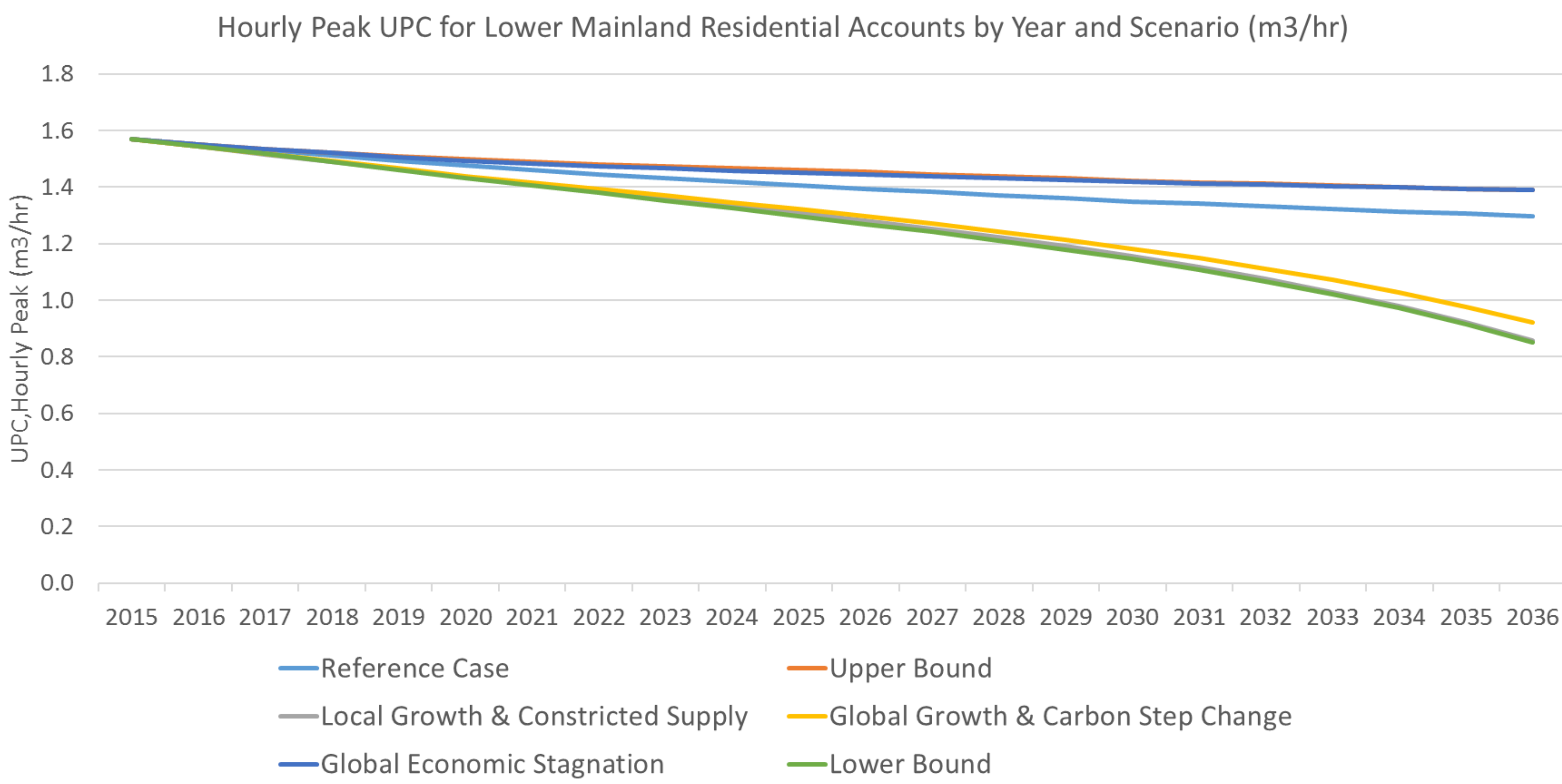
Reference forecast projects a decline in hourly peak UPC of approximately 17%.

Reference Case Forecast - Annual



Different scenarios forecast declining annual UPC between 10% and 43%.

Reference Case Forecast - Peak



Different scenarios forecast declining hourly peak UPC between 11% and 46%.

Peak Demand Forecasts

Anticipated outcomes…

- Peak demand forecasts derived for each end use scenario as well as the traditional forecast method
- Determine the differences in infrastructure requirements at peak demand for each end use scenario
- Explore if DSM programs influence on end use might also influence peak demand forecasts and the corresponding infrastructure needs

Questions?

- Introduction & objectives
- Feedback from Workshop 1
- Annual Demand Reference Case
- Scenario Analysis Review
- System Capacity Planning
- **Wrap-Up & Next Steps**

Energy at work

FORTIS BC™

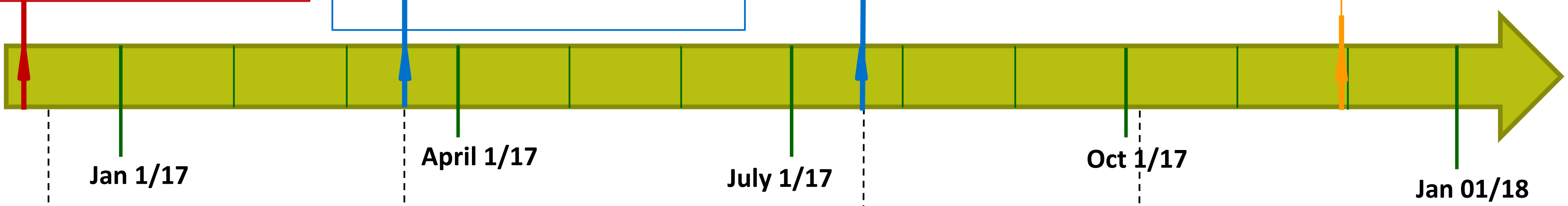
Next steps

Fall RPAG Workshop (November 2016)
- Introduction
- Planning environment
- Scenario analysis methods & qualitative inputs

Spring RPAG Workshop (April 2017)
- Annual demand forecast results
- Quantitative scenario analysis review
- System capacity planning methods

Summer RPAG Workshop (June 2017)
- NGT annual demand forecast results
- DSM analysis results
- System requirements and options
- Regional supply resource options
- Site visit?

Submit LTGRP to BCUC Nov. 30, 2017



LTGRP Regulatory Review

- Prepare customer and annual demand forecast
- Iterate quantitative scenario inputs
- Implement methods for linking annual and peak demand
- Update planning environment information
- Complete Conservation Potential Review (CPR)

- Prepare system requirements and options analysis
- Prepare regional supply resource analysis
- Complete DSM analysis

- Prepare directional rate and GHG impact analysis
- Finalize data integration
- Prepare regulatory submission document

Thank you

For further information,
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