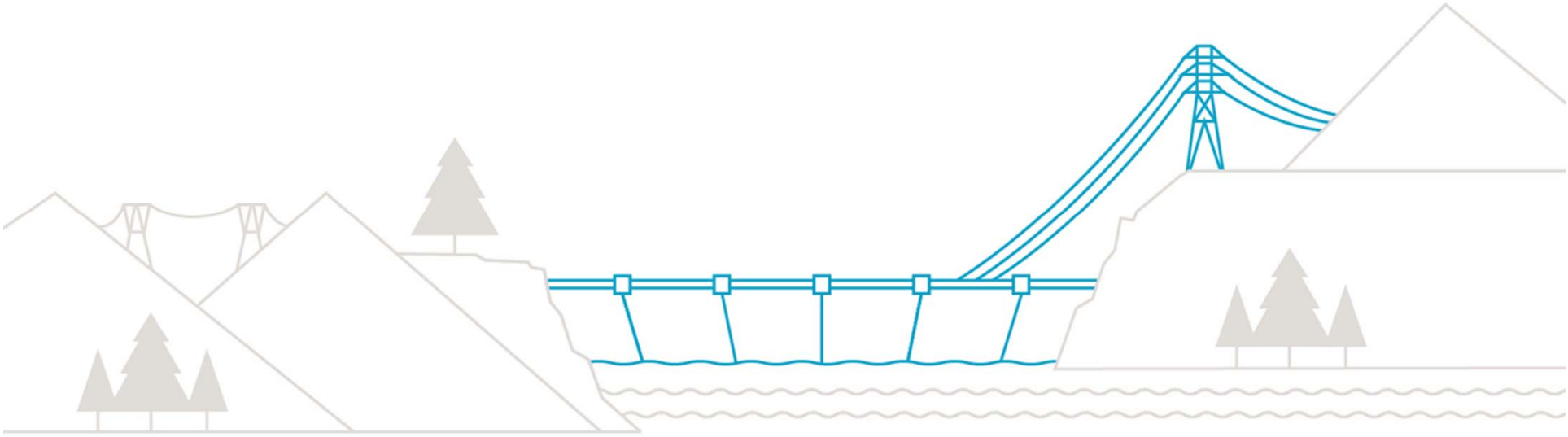
Integrated Resource Plan
Technical Advisory Committee

Meeting – October 3, 2016



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Recap from Last Meeting

- We met on March 30, 2016, after the interim RRA filing, but before the final update on the load forecast, and before the release of the Climate Leadership Plan

- Discussed the review of the 2013 IRP:
  - A commitment in the 2013 IRP – Clean Energy Strategy
  - Intention – to consider if new acquisitions are needed before 2018 IRP
  - Not to address actions in the RRA F2017 – F2019 period
- Pending any surprises – expected no new acquisitions needed in advance of what will be determined in the 2018 IRP
- Discussed/gathered initial thoughts on issues looking ahead to 2018

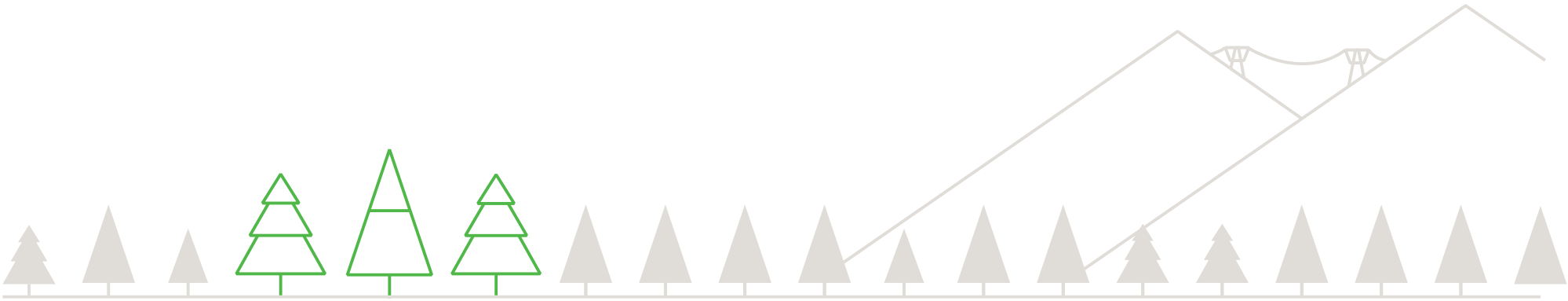
- Today, we will be completing the review of the 2013 IRP

Meeting Agenda

Time	Item	Presenter
9:00 – 9:15	Welcome	Anne Wilson / Randy Reimann
9:15 – 10:15	**Load Forecast** • What's changed?	John Rich
10:15 – 10:30	Break	
10:30 – 11:15	**Load Resource Balance – completing the review of the 2013 IRP** • What's changed? • Status of IRP actions • Climate Leadership Plan	Kathy Lee
11:15 – 11:45	**2018 IRP** • Key considerations and activities	Kathy Lee
11:45 – 12:00	**Close and next steps**	Anne Wilson

Load Forecast

John Rich



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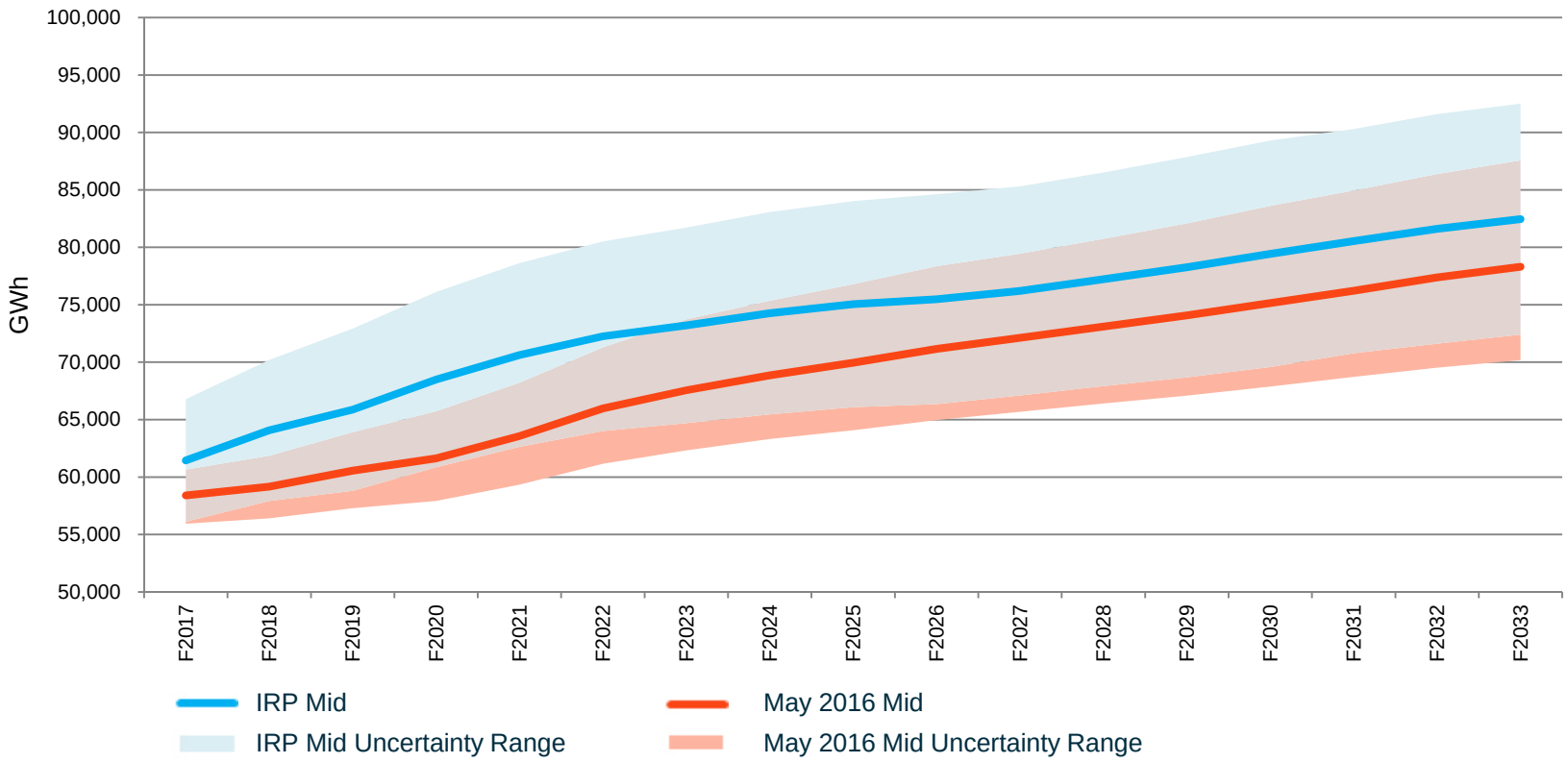
LOAD FORECAST

Summary

- May 2016 Load Forecast (published in F17 to F19 RRA) – reflects information up to April 2016
- Forecast continues to see growth across all three sectors, however, growth rate is lower relative to the 2013 Integrated Resource Plan (IRP)
- May 2016 Load Forecast before demand-side management (DSM) with losses, is lower by about 4,100 GWh or about 5% relative to the IRP forecast (by F2033), mostly due to a decline in the transmission sector
- Core methodology remains unchanged – May 2016 LNG forecast is based on public information on loads and timing for service
- After consideration of DSM savings, the forecast of load growth is similar to other North American utilities

May 2016 (RRA) vs. 2013 IRP Load Forecast Before DSM

Total Integrated Requirements with LNG



- The solid lines shown in the graph are the mid forecasts
- The drop in the two forecasts is mainly due to a change in commodity prices and its impact on industrial loads

**The IRP Mid Forecast, shown in the graph, reflects estimates of the DSM savings prior to F2016, and the associated persistence over the forecast period. This applies to all graphs.*

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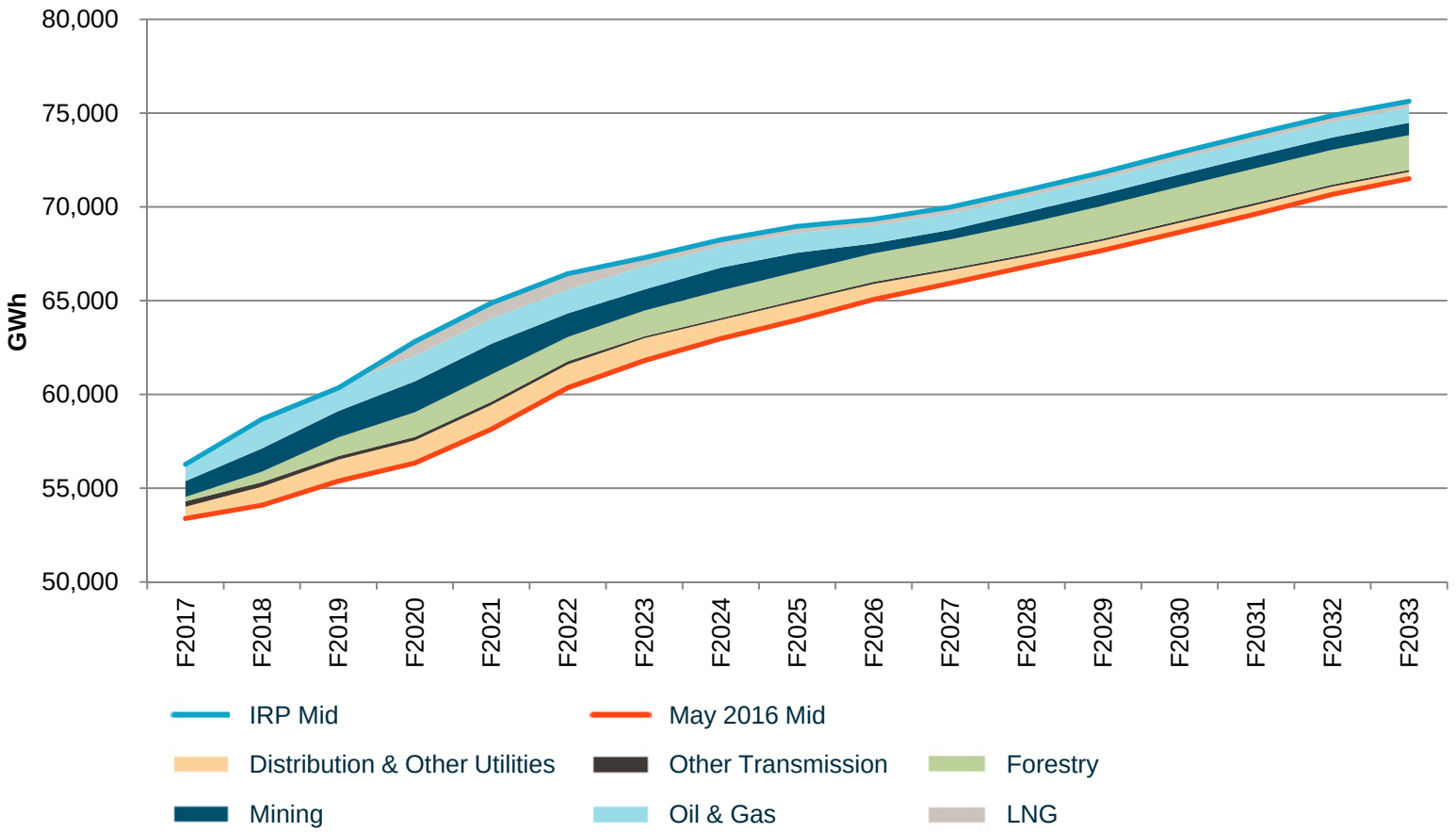
Forecast Difference Breakdown

Total Firm Sales May 2016 vs. 2013 IRP Before DSM



- Transmission sector accounts for most the change
- In the long term, LNG load forecast is about the same

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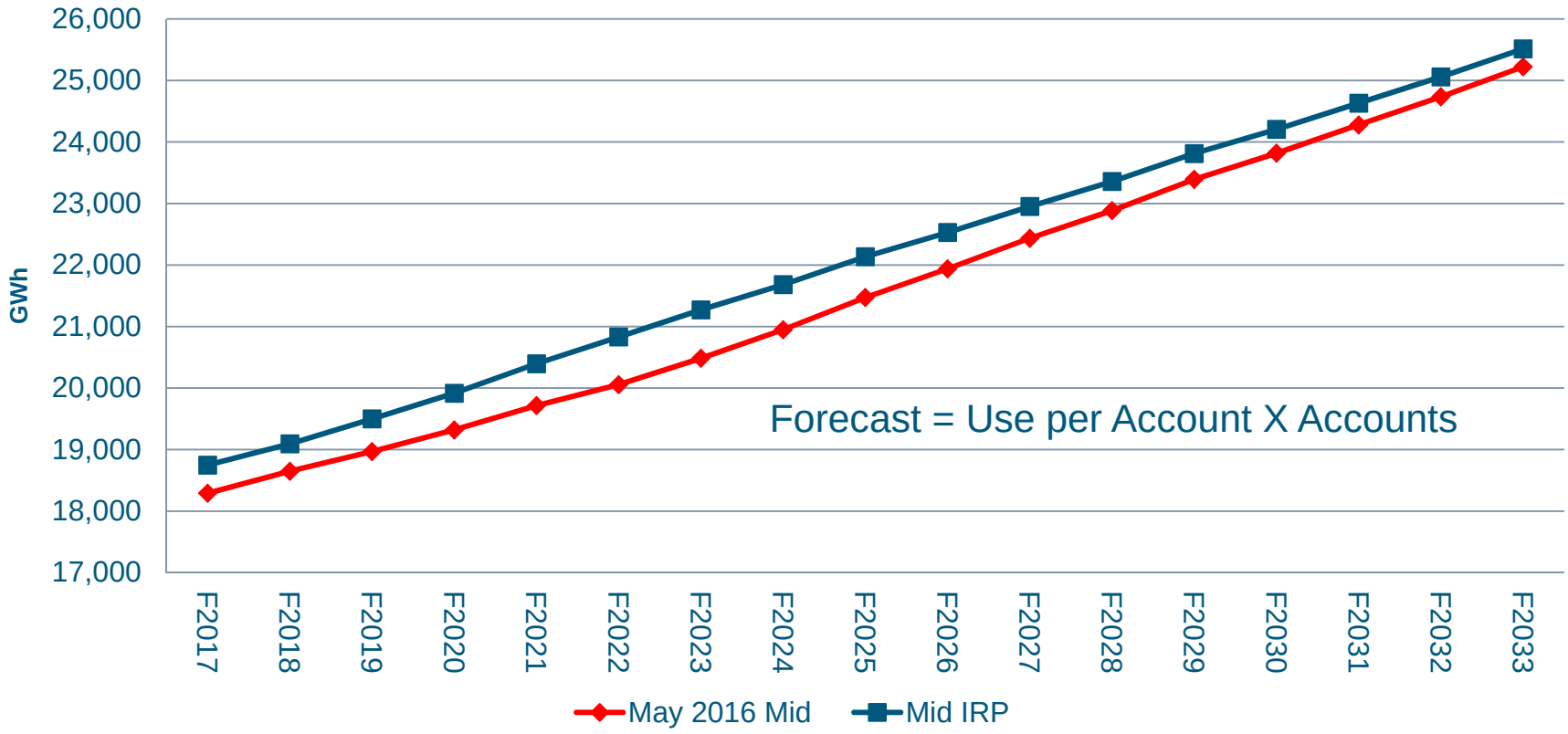
Residential Forecast

May 2016 vs IRP Before DSM



- Both drivers of the forecast (use per account) and accounts are lower relative to the previous forecast

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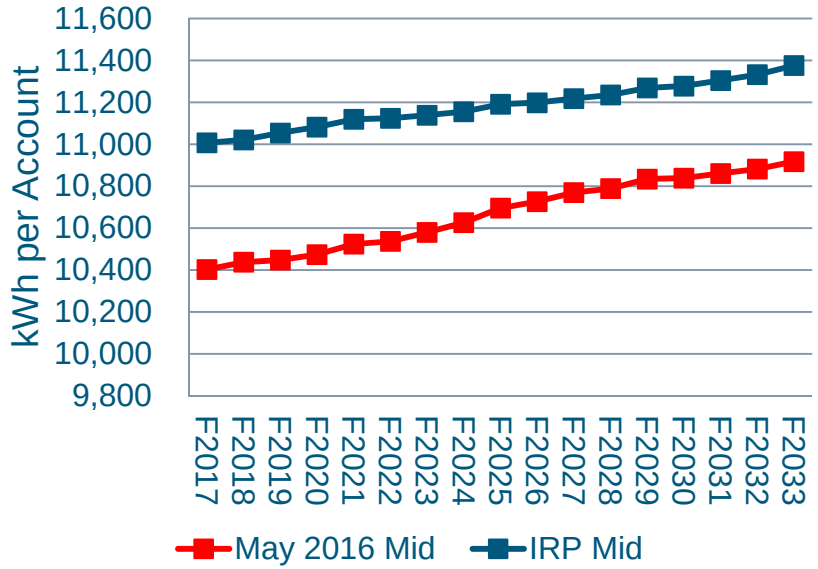
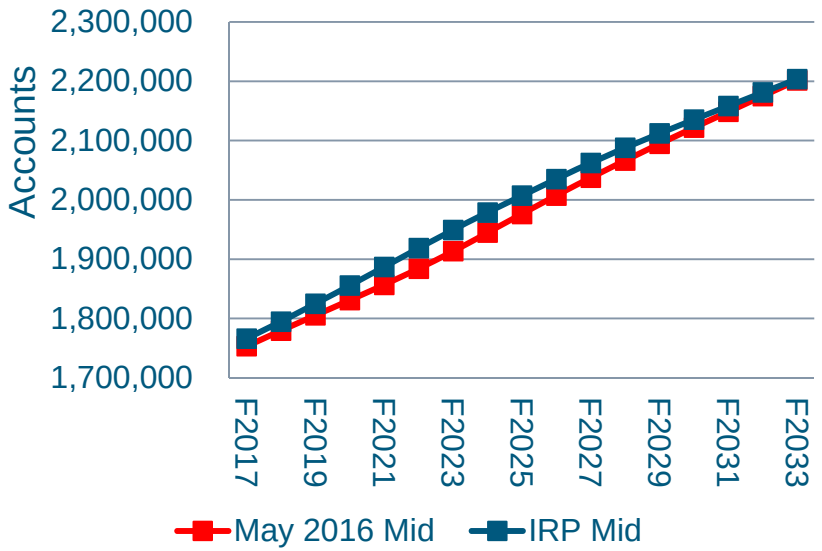
Use Per Account and Accounts Forecasts

May 2016 vs IRP





Changes between forecast mainly due to:

- Current forecast starts from a lower point as growth in use per account has slowed
- Revised assumption on average efficiency of appliances – enhanced efficiency projection
- Replacement of home computers with tablets

Changes between forecast mainly due to:

- Revised economic projection and population projections

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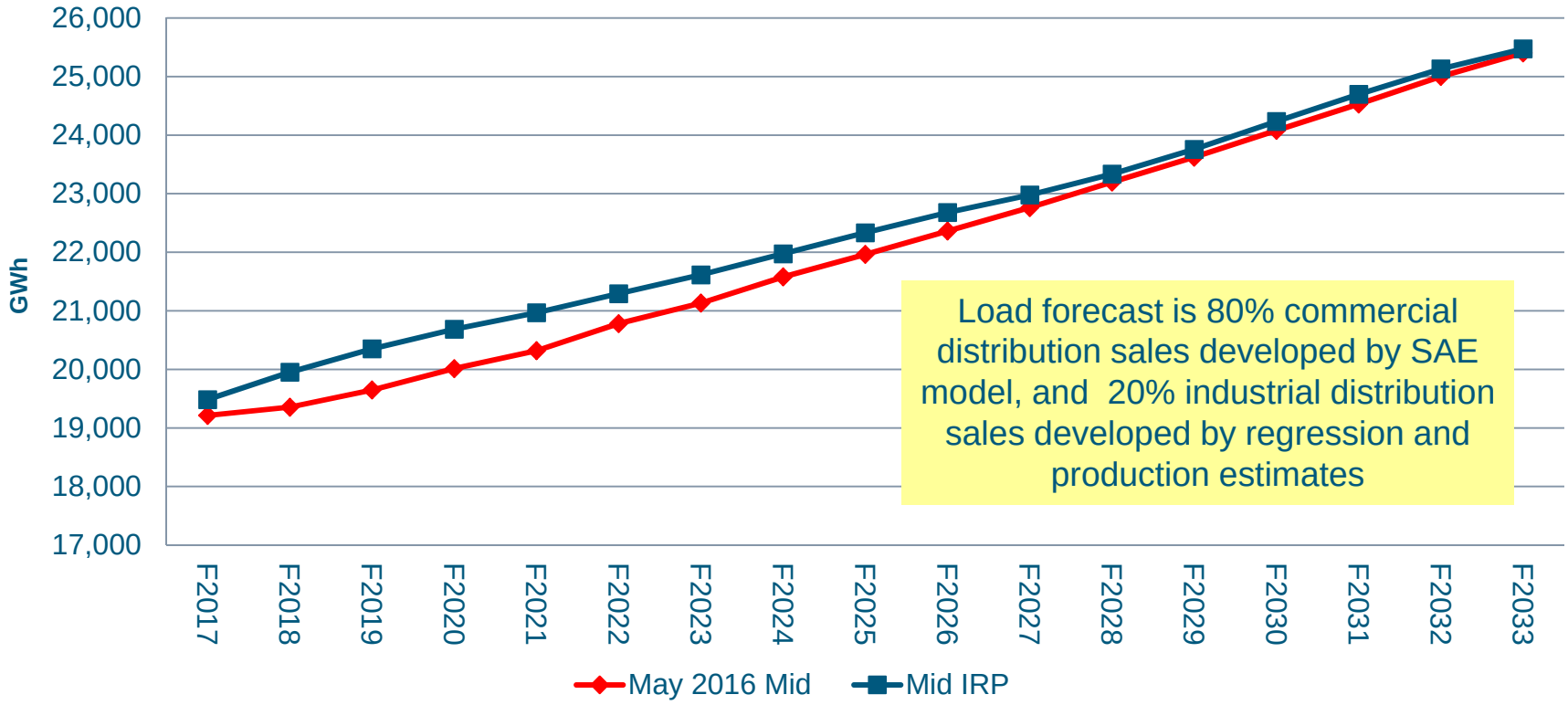
General Sales Forecast

May 2016 vs IRP Before DSM



Changes between forecast due to:

- Forecast starts from a lower point; slower growth than anticipated
- Revised economic forecast: slower projected growth in drivers
- Projected increase in average efficiency in commercial end use of electricity

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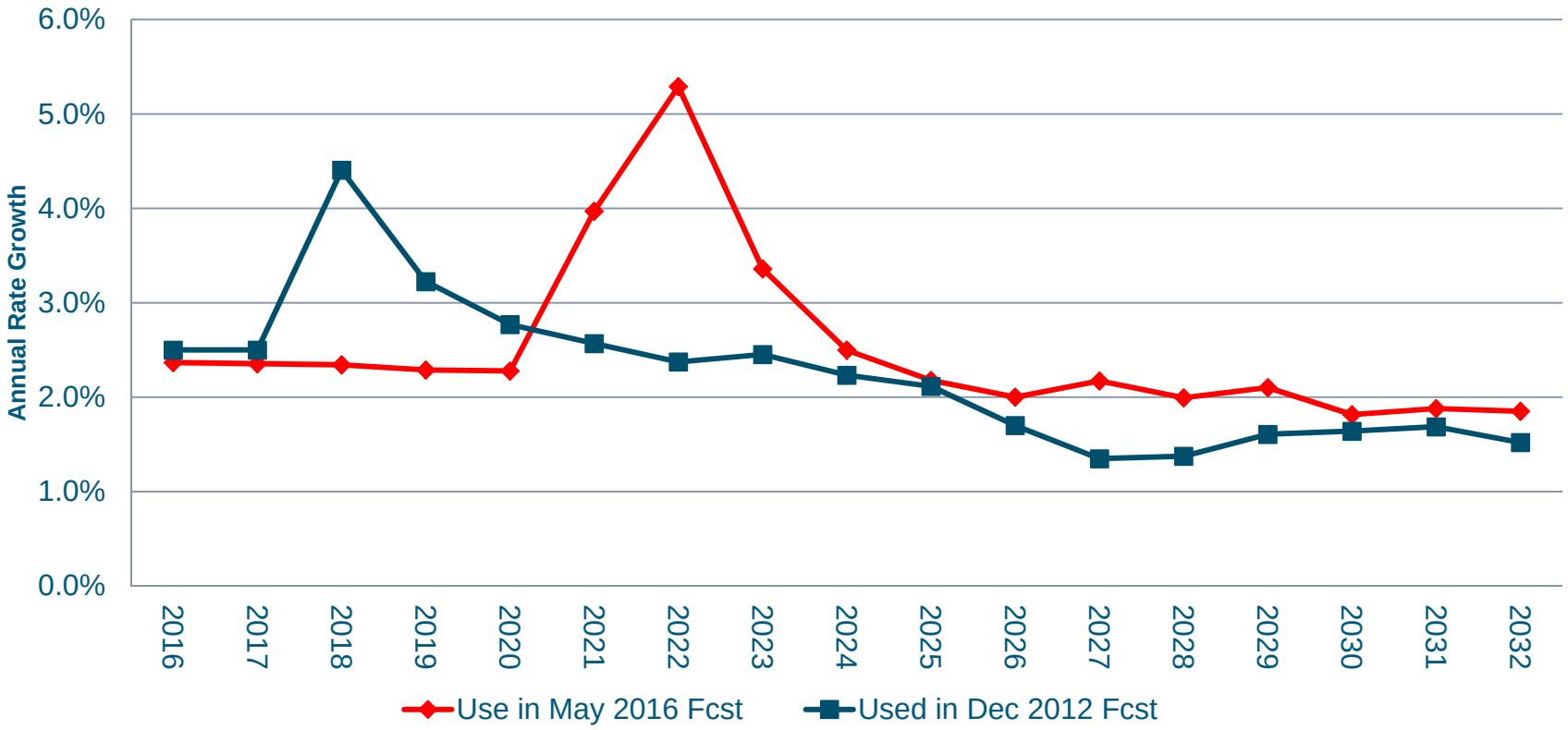
Real GDP Forecast Growth Projections



- IRP forecast anticipated early development of LNG industry and investment relative to the May 2016 forecast
- Increase in real GDP growth is due an increase in capital investment in northern B.C. – this is not a driver of sales in the Lower Mainland

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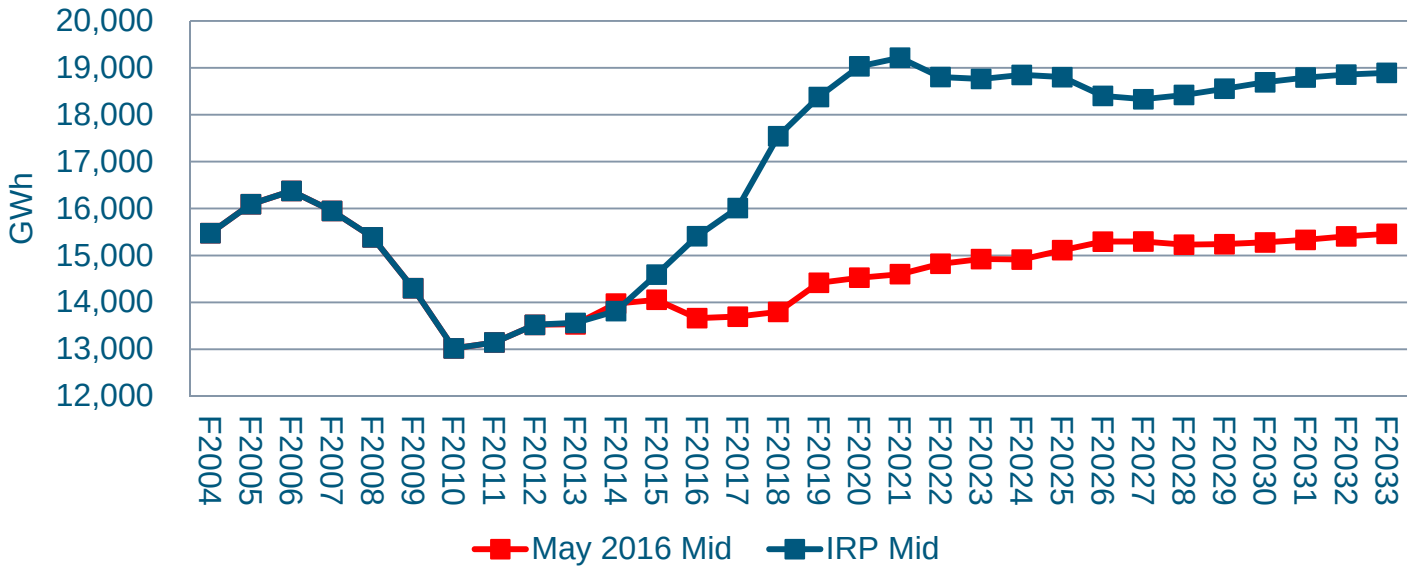
Transmission Sales*

May 2016 vs IRP Before DSM



Over the 20 year forecast period, the average differences is:

- Oil and Gas: Lower by 1,000 or 28% due to delays in gas projects, LNG developments, reduced expectations on oil pipeline projects
- Mining: Lower by about 950 or 26% due to lower commodities prices and delays in projects requesting electricity service
- Forestry: Lower by 1,500 or 41% due to loss in base load, lower commodity expectations, and reduced out look for major mills
- Other: Lower by 200 or 4% due to push back in expansion at major ports

*** LNG load not included in comparison**

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Commodity prices reduced forecasts

Natural Gas

	2013	2016	% Change
Gas ($/mmBtu)	2.8	2.1	↓24%
LNG ($/mmBtu)	16.2	8.4	↓48%

Mining

	2013	2016	% Change
Coal (metallurgical) ($/mt)	130	68	↓48%
Copper ($/lb)	3.6	2.2	↓39%

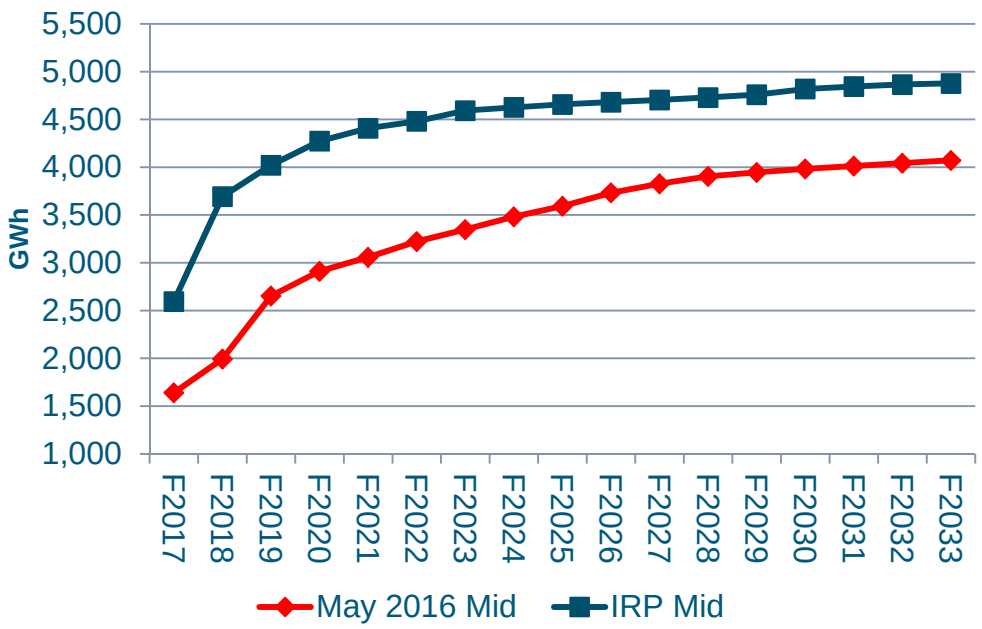
Pulp & Paper

	2013	2016	% Change
Kraft pulp ($/tonne)	660	610	↓8%
Thermo-mechanical pulp ($/tonne)	550	380	↓31%
Paper, newsprint ($/tonne)	640	520	↓19%
Lumber ($/m fbm)	300	280	↓7%

Forecasting approximately **$3.5 billion (or 7%) less revenue** over the duration of the 10 Year Rates Plan compared to the assumptions at the time the plan was announced in 2013.

Oil and Gas*

May 2016 vs IRP Before DSM



*** LNG not included in comparison**

Gas Sector

- Domestic gas markets currently over supplied, and LNG plants deferred in service
- Both of these has led to delays and reductions in upstream gas projects

Pipeline Sector

- Removed proposed Enbridge pipeline project from the forecast; project is not in interconnection queue

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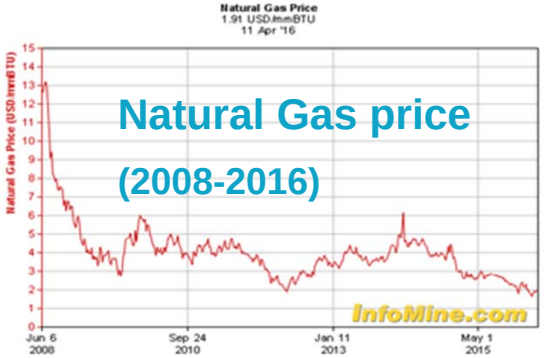
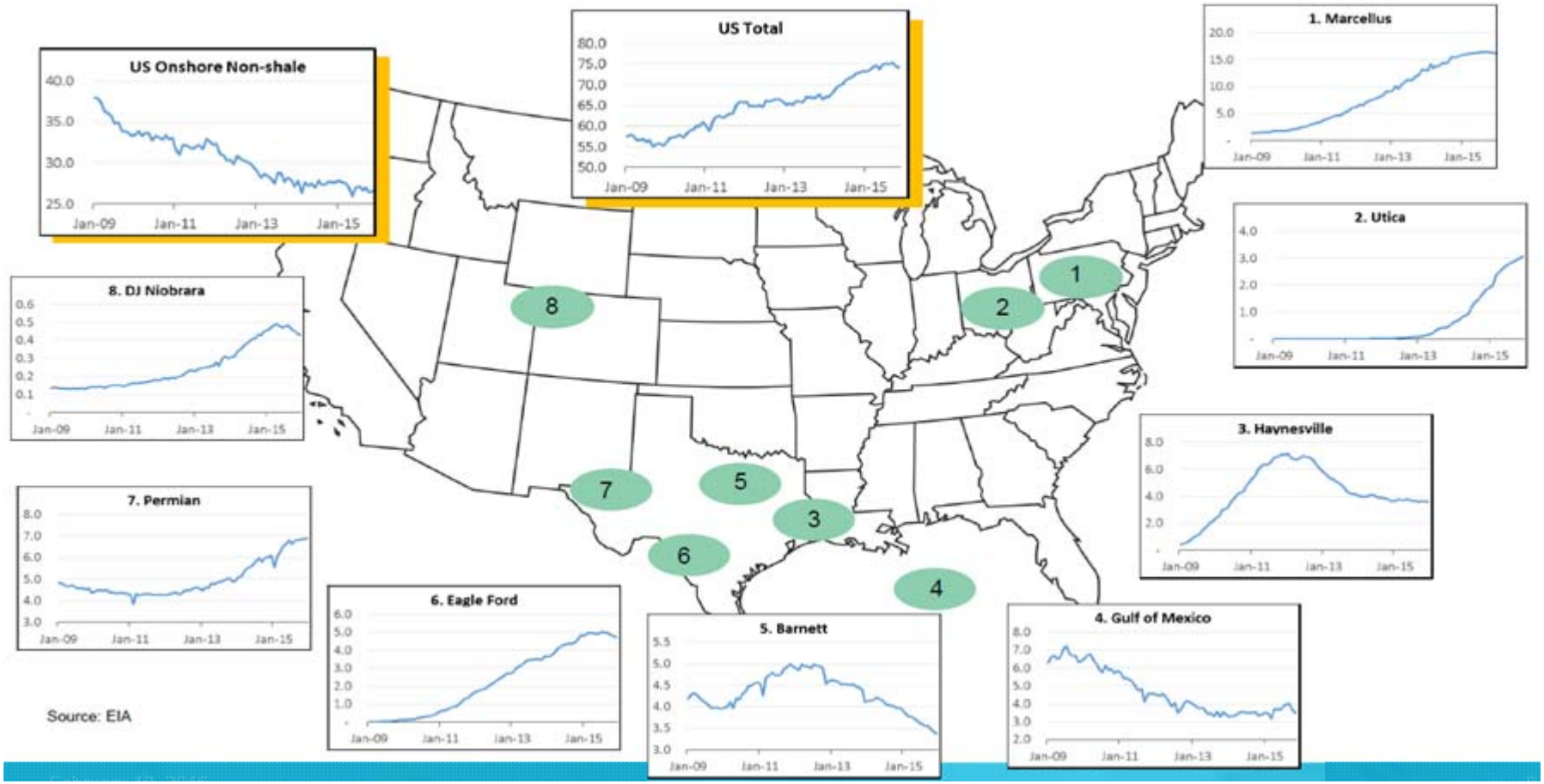
North American Natural Gas

The supply situation: a US gas basin perspective

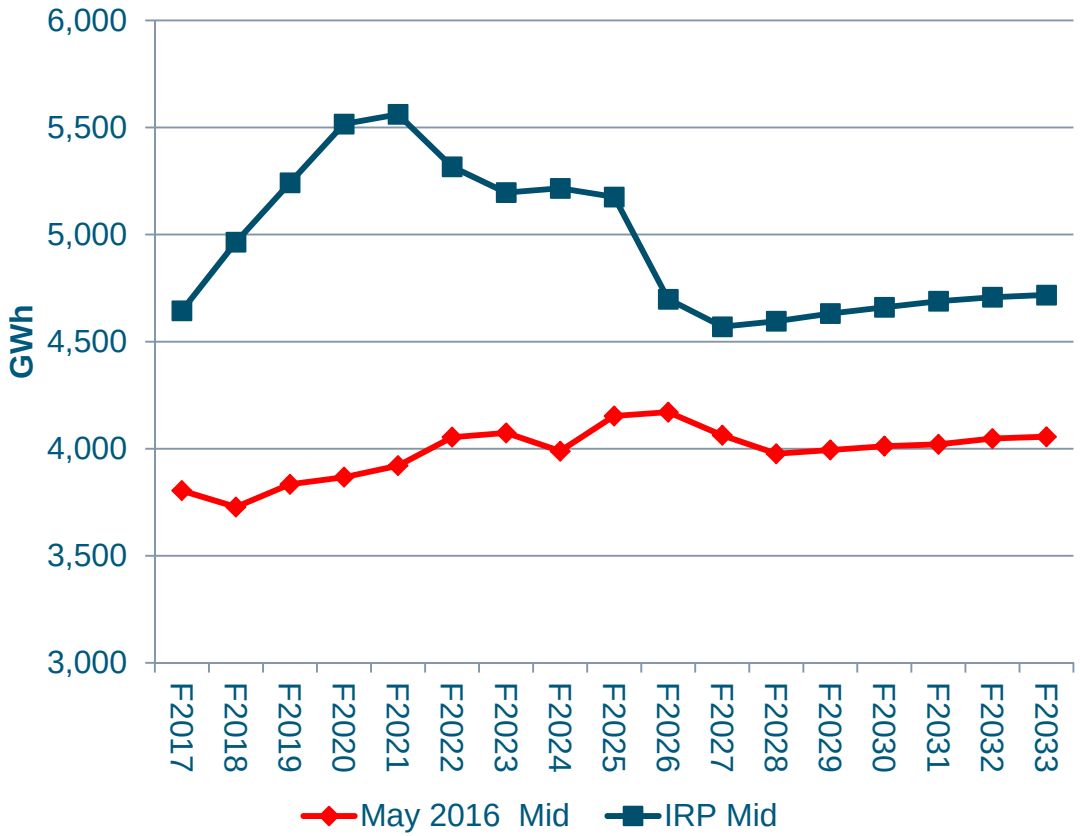
- **US gas production slowing due to oversupply**





Mining

May 2016 vs IRP Before DSM



Forecast difference:

- Lower commodity price outlooks for metals and coal
- Deferrals of new project in-service dates
- Deferred restarts of currently idled production (Endako)
- Recent announced shutdowns (including Huckleberry and Coal Mountain)

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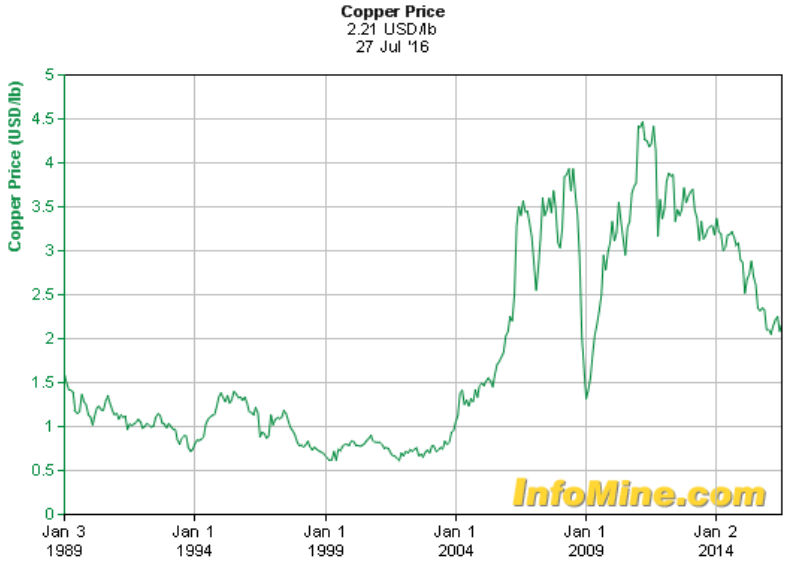
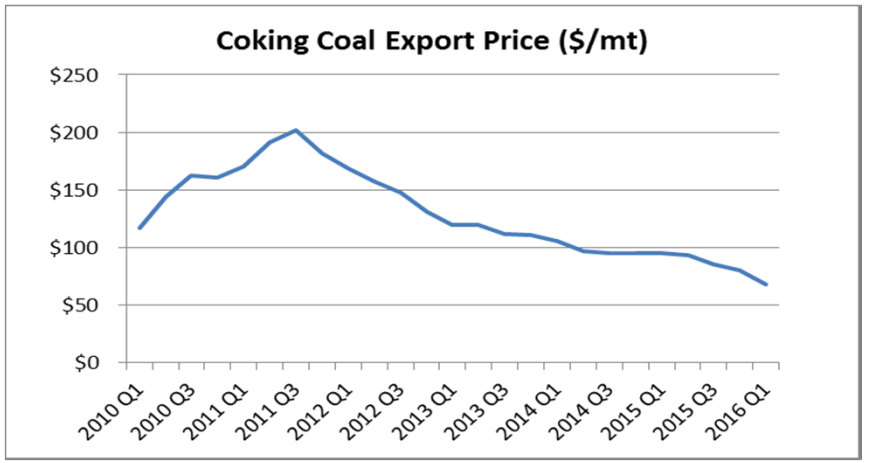
Commodity Price History





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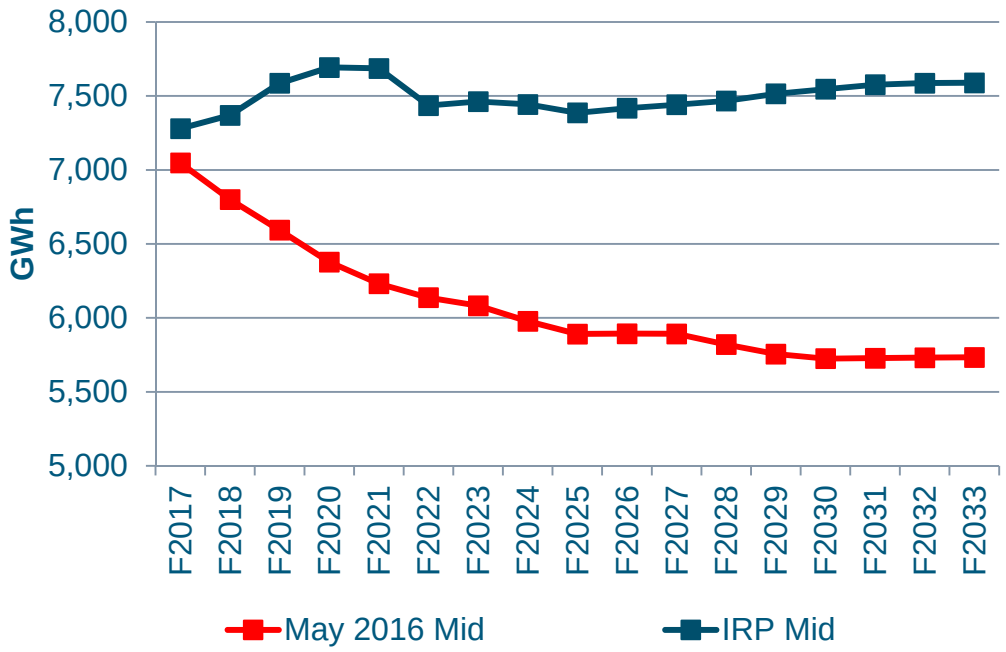
Pulp & Paper, Wood, and Chemicals



Key points:

- Loss of base load; closure of TMP facilities at Howe Sound
- Continued weakness, especially in pulp sector due to continued decline in demand for newsprint and competition from other parts of the world (Eucalyptus Kraft Pulp Capacity in Latin America)
- Reduced outlook on other TMP mills

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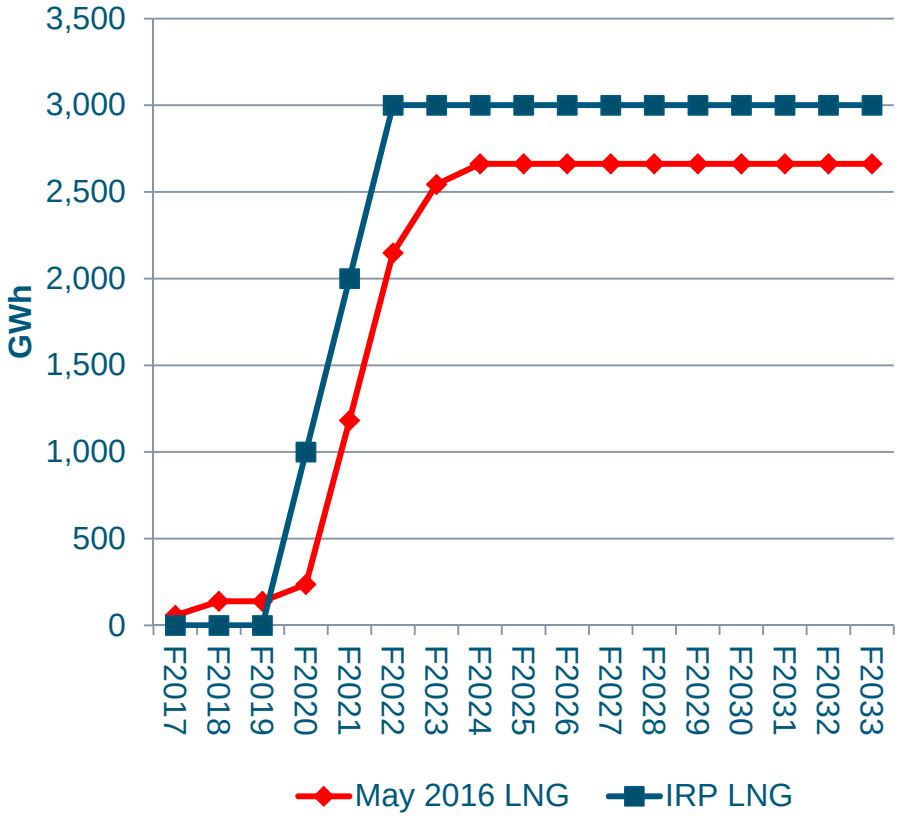
Liquefied Natural Gas (LNG)

May 2016 vs IRP



Key points:

- LNG industry is high profiled
- LNG industry is in a dynamic development stage
- May 2016 forecast reflects public information on load and in service dates, from three major LNG proponents which have requested electricity service from BC Hydro

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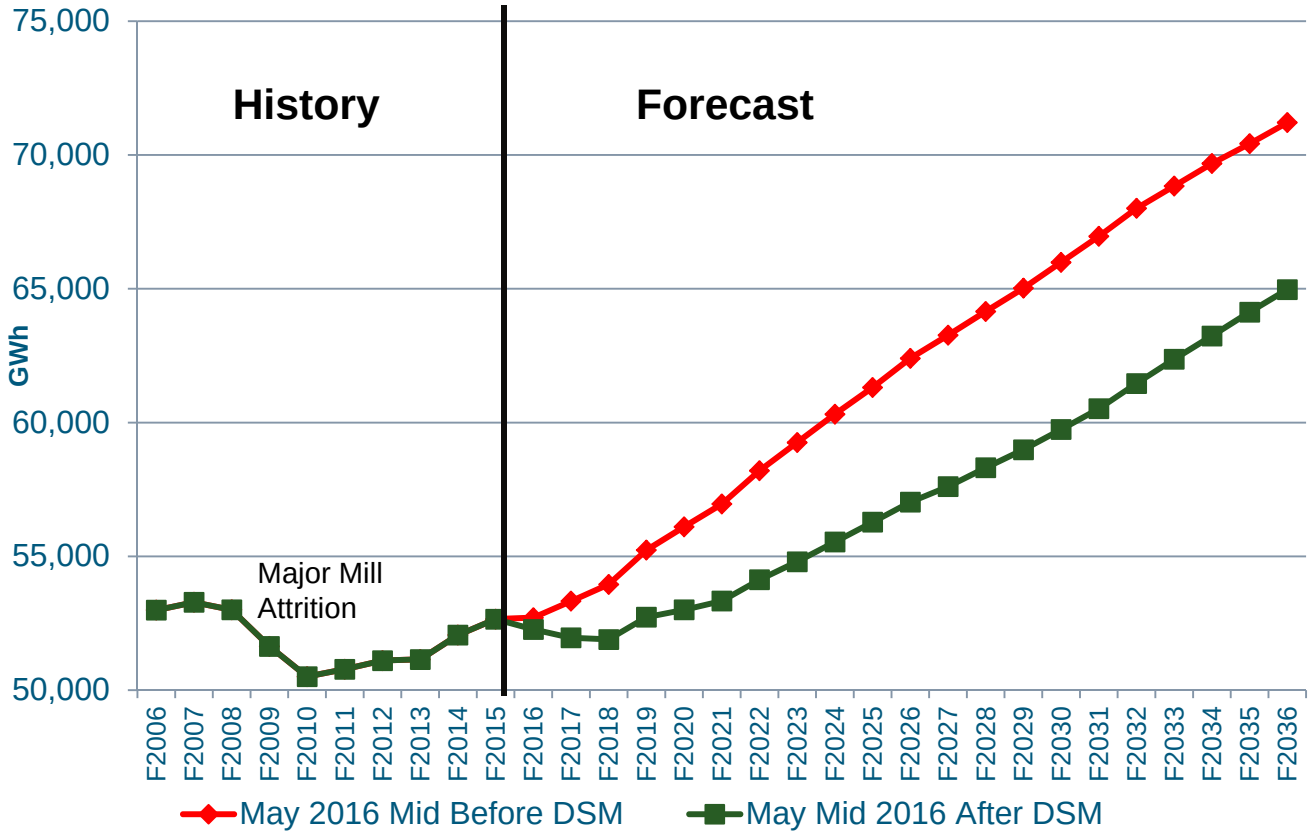
Total Firm Sales Growth

May 2016 Forecast Before and With DSM



Key points:

- There was major mill attrition over the last 10 years
- Itron survey data shows the forecast average growth rate, from 60 various utilities, is about 1% per year

	WITHOUT LNG BEFORE DSM	WITHOUT LNG WITH DSM		WITH LNG BEFORE DSM	WITH LNG WITH DSM
10 YR HISTORY	0.2%	0.2%		0.2%	0.2%
10 YR FCST	1.7%	0.9%		2.1%	1.3%
20 YR FCST	1.5%	1.1%		1.7%	1.3%

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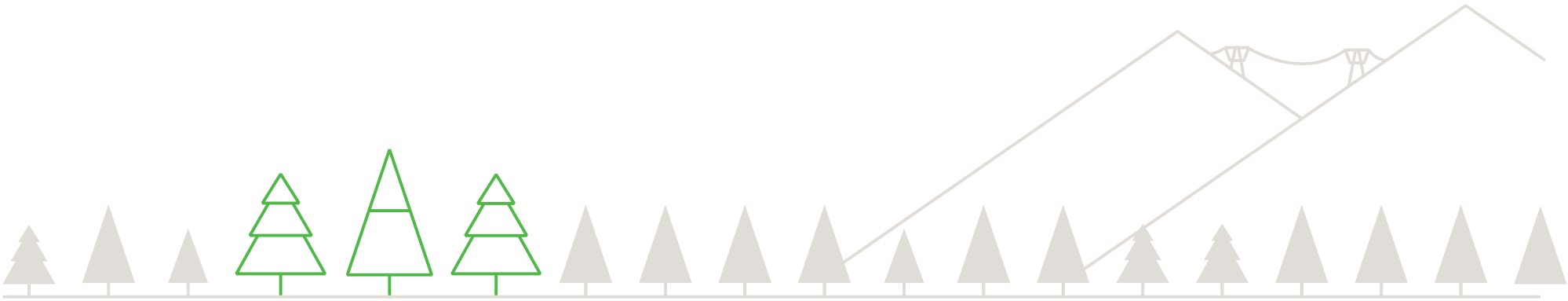
Load Resource Balance

Completing the Review of the 2013 IRP

Kathy Lee



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Load Resource Balances Overview

There is a greater or earlier need for capacity than energy

Sufficient resources planned to meet need until late 2020s

- Before planned resources, need for energy in F2022 and capacity in F2020
- After planned resources per Recommended Actions in 2013 approved IRP, sufficient energy until F2034 and capacity until F2029
- Load Resource Balance in F2017 to F2019 Revenue Requirement Application

Load Resource Balance
Changes since the 2013 IRP

Changes since 2013 (in addition to the load forecast):	
Site C	Under construction, with expected in service date for all units by F2025 (one year delay compared to 2013 IRP)
Demand-side management	Energy savings from conservation rates less than forecasted, but energy saving from codes and standards have increased
Independent Power Producer Supply	Expected supply has increased, for example, more projects reached completion than expected
Major Maintenance	Mica Units 1 to 4 maintenance will require taking one unit out of service at a time for 12 to 18 months each i.e., about 400 MW of dependable capacity unavailable up to six years (starting in F2025)

Changes in the Load Resource Balance since 2013 IRP

Additional changes to the load resource balance:

- North Coast Capacity Additions: Assumed none before end of fiscal 2024 (compared to 400 MW estimated in 2013 IRP). BC Hydro will continue to assess regional needs.
- Demand-Side Management (DSM): BC Hydro continued a moderation strategy by reducing planned DSM expenditures to achieve cost savings, keep rates low and respond to customer and system needs (consistent with Government's expectations per Minister's Letter of Support on DSM dated December 16, 2015).

  The DSM expenditures proposed in RRA reflect the following objectives/approach:

  - exceed the "at least 66%" conservation objective in the CEA
  - provide access to conservation opportunities and information for all customer groups
  - discontinue or reduce programs that are not as cost-effective and have served their purpose, reduce marketing dollars and adjust certain offers
  - support areas best suited to meet evolving customer and resource needs such as building codes and standards, capacity-focused DSM and customer energy management solutions
  - leverage investments in smart meters and a smart grid by providing customers with the information they need to make smart energy choices

“At least 66%” Conservation Objective

- Clean Energy Act objective – to reduce expected increase in demand for electricity by year 2020 by at least 66% [by F2021 from F2008]
- Metric is highly sensitive to load forecast - has been highly variable
- Currently at 106% (based on mid Load Forecast without LNG, consistent with IRP and Minister’s understanding)
- 90%, if based on mid Load Forecast with LNG

	2013 IRP	DSM Plan (RRA)
% Load Growth at F2021 (mid LF, wo LNG)	116%	106%
% Load Growth at F2021 (high LF, w LNG)	64%	59%
% Load Growth at F2022 (mid LF, w LNG)	85%	76%

Status of 2013 IRP Actions
Other highlights

Actions	Update
Optimize existing portfolio of IPP resources	Pursuing renewal of expiring EPAs
Clean Energy Strategy Advance a set of actions to support a healthy, diverse clean energy sector, and promote clean energy opportunities for First Nations' communities. Review of the 2013 IRP to "assess whether new information is observed to warrant an update to the November 2013 IRP on the recommendation of a new energy call."	SOP Optimization process underway to determine ways for the program to better reflect technological advancements, changing system needs, and to find cost savings to keep rates low. Completing the IRP review today (concluding in later slides that no need for additional acquisition before 2018 IRP)

Status of 2013 IRP Actions
Other highlights

Action	Update
Advance Revelstoke Unit 6 resource smart project	Now included in Base Resource Plan with in service date of F2027 Continue to maintain earliest in service date (F2022, one year delay from IRP)
Pursue DSM capacity conservation	Load curtailment pilot with industrial customers Year 2 Demand response pilot with residential and commercial customers is underway
Advance reinforcement along existing GMS-WSN-KLY 500 kV transmission line to be available by F2024	Currently in early stage of identification phase
Reinforce South Peace transmission network to meet expected load	Peace Region Electricity Supply (PRES) project in feasibility stage
Advance reinforcement of the transmission line from Prince George to Terrace, including the development of three new series capacitor stations and improvements to the existing substations to be available by F2020.	On hold – this project is funded by LNG Canada who has delayed its final investment decision

Climate Leadership Plan

Released by government August 18, 2016

- Re-affirms the 2050 emissions reduction target of 80 per cent below 2007 levels
- 21 initial actions to reduce emissions and to create green jobs
- BC Hydro can support a number of Climate Leadership Plan actions (directly or indirectly):
  - Incentives for purchasing a clean energy vehicle
  - Supporting vehicle charging development for zero emission vehicles
  - 10-year plan to improve B.C.'s transportation network (expanding transit)
  - Encouraging development of net zero buildings
  - Reducing Emissions and Planning for Adaptation in the Public Sector
  - Making B.C.'s electricity 100% renewable or clean (100% Clean)
  - Using electricity to power natural gas production and processing (Electrify upstream gas)
  - Efficient electrification

Climate Leadership Plan

Additional details on actions most relevant to electricity planning

- **100% Clean**
- Going forward, 100% of the supply of electricity acquired by BC Hydro in B.C. for the integrated grid must be from clean or renewable sources,
- Except where concerns regarding reliability or costs must be addressed
- Acquisition of electricity from any source in B.C. that is not clean or renewable must be approved by government through an Integrated Resource Plan

Climate Leadership Plan

Additional details on actions most relevant to electricity planning

- **ELECTRIFY UPSTREAM GAS**
  - B.C. government is in dialogue with the federal government to provide the necessary capital to develop the required infrastructures (e.g. Peace Region Electricity Supply, North Montney Power Supply Project).
  - Construction of this infrastructure would begin once LNG companies make their final investment decisions
  - Programs are being developed to close the gap between electricity and natural gas costs

- **EFFICIENT ELECTRIFICATION**
  - B.C. government is working with BC Hydro to expand the mandate of its DSM programs to include investments that increase efficiency and reduce GHG emissions

Climate Leadership Plan (CLP)

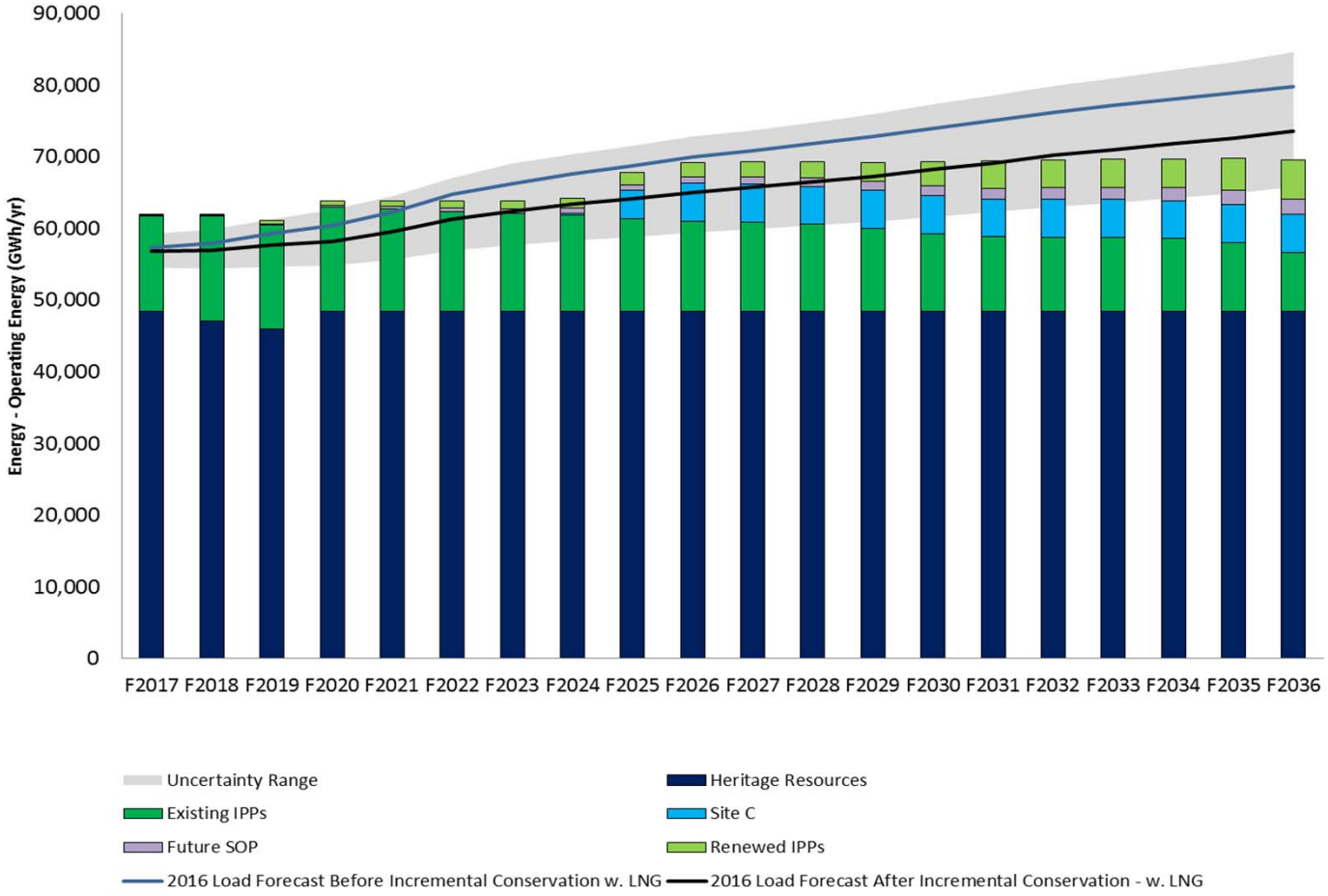
(Policy actions, not yet legislated)

What does CLP mean for Resource Planning?	Any IRP change needed before 2018 IRP? No

Changes in demand for electricity:
 	
↑ due to electrification (e.g., in the transportation sector, oil and gas sector, emissions reduction plans), and
 	
↓ due to more efficient buildings
 	
Changes expected to be gradual as initiatives are being put in place
	Expect to have sufficient energy resources to support the CLP in the near term:
	
	Expect greater need for capacity resources but IRP actions are prepared for this:
	
	• Default: Revelstoke 6 – IRP is maintaining earliest in service date of F2022
	
	• Alternatives (if reliable and more cost effective):
	  • capacity focused DSM or rate options
	  • the remaining 50% capacity from biomass renewal
	  • new greenfield

Explore cost effective clean capacity options: New capacity resources are needed after Revelstoke 6 (~F2029 on an expected basis based on LRB in RRA, but sooner given CLP and under contingency conditions) Next supply side clean capacity option has a large step up in cost.	

Energy LRB with planned resources



Includes:

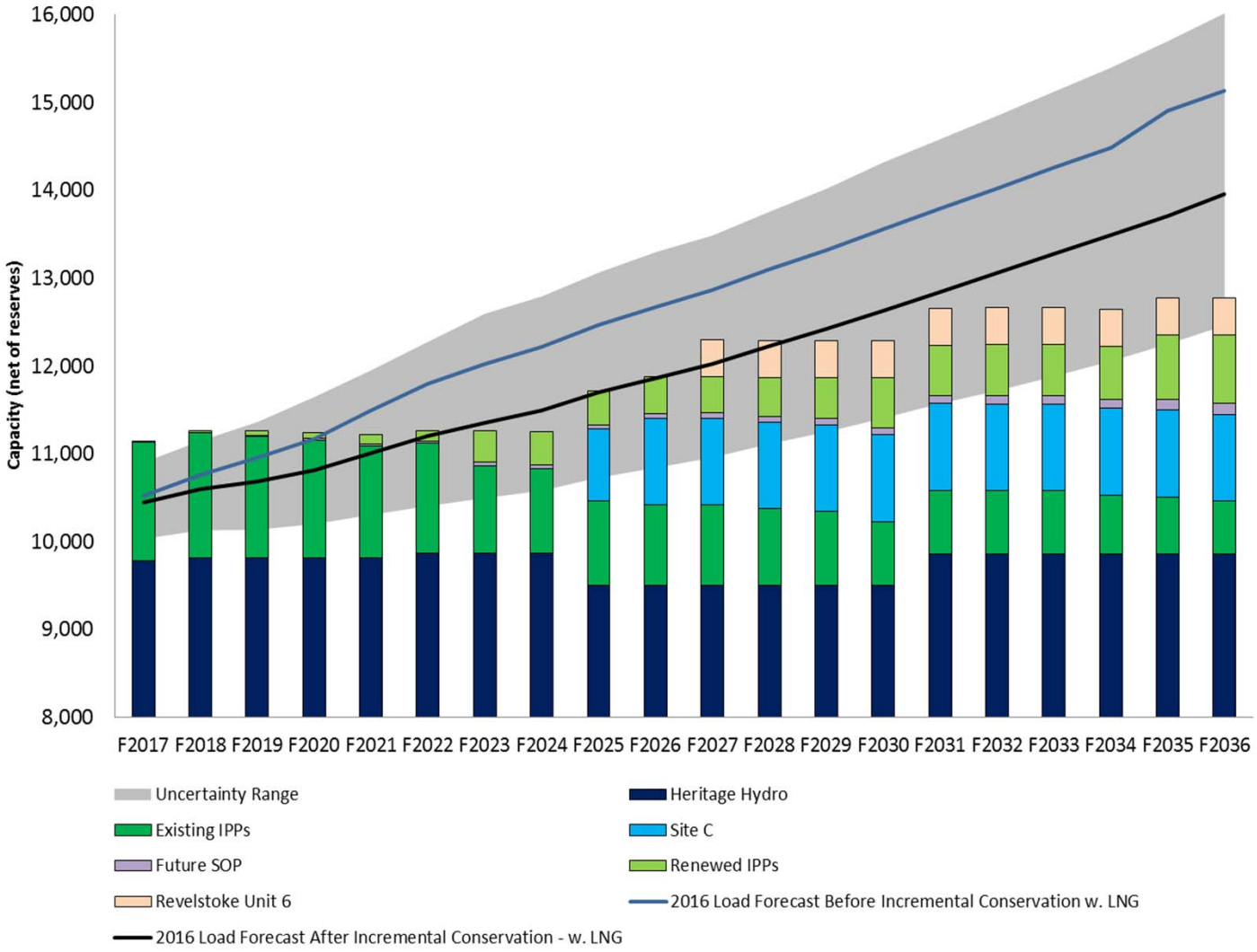
- Site C (under construction)

And planned resources:

- DSM
- EPA renewals
- Standing Offer Program

	F2017	F2018	F2019	F2020	F2021	F2022	F2023	F2024	F2025	F2026	F2027	F2028	F2029	F2030	F2031	F2032	F2033	F2034	F2035	F2036
2016 RRA planning margin as a % of Net Load	113%	115%	115%	114%	111%	108%	106%	105%	109%	110%	109%	107%	106%	105%	103%	102%	101%	99.9%	99%	97%

Capacity LRB with planned resources



Also includes

- Revelstoke Unit 6
- Cost effective bridging option to Site C by relying on the market for short term

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Climate Leadership Plan

Additional BC Hydro involvements

- To expand the role of DSM programs to support Efficient Electrification
  - Section 18 of the Clean Energy Act enables undertakings for the purpose of reducing GHG in B.C.
  - BC Hydro currently in discussions with government and customers to explore the potential

- Be prepared to develop required infrastructure to electrify upstream gas
  - Provincial government has requested federal funding
  - BC Hydro in feasibility phase for the Peace Region Electricity Supply project

- Support vehicle charging development for zero emission vehicles
  - BC Hydro has installed 30 Direct Current Fast Charging network of stations and is planning for expansion

- Be prepared to develop mandated 10-year emissions reduction and adaptation plans for provincial public sector operations

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2018 IRP

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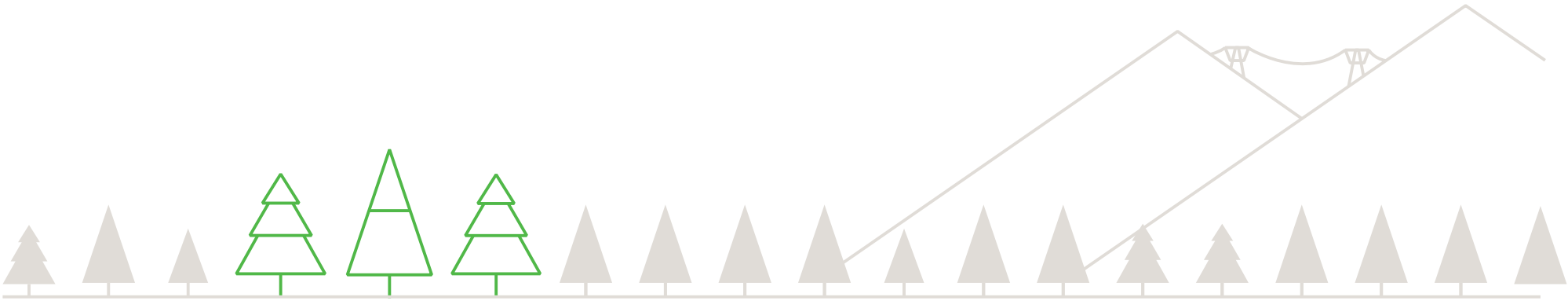

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2018 IRP key considerations

Planning environment continues to evolve, with new uncertainties of potential paradigm shifts facing the industry today

Key uncertainties include:

Commodity Prices
e.g., oil, gas prices

Market Evolution
e.g. Alberta opportunities, U.S.

Changing Customer Preferences
e.g., more choices, environmentally conscience

Rapid Technological Advancements
distributed energy resources
e.g., solar, battery storage, electric vehicles – more or less load and its interaction with the grid

Climate Change
Mitigation (policies), adaptation (impacts)

Industry Evolution
Declining load growth, new industries

ICT* Improvements & Deployment
e.g. smart meters/grid

Topics to address include:

- Demand-side management target beyond 2020
- Evolving system needs and market conditions

  e.g., freshet, capacity characteristics, locational value, grid requirements (T&D), California solar integration challenge

In preparation of the 2018 IRP, BC Hydro will explore future worlds (scenarios) and is contemplating the process for engagement.

* Information & Communications Technology

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2018 IRP – Distributed Energy Resources

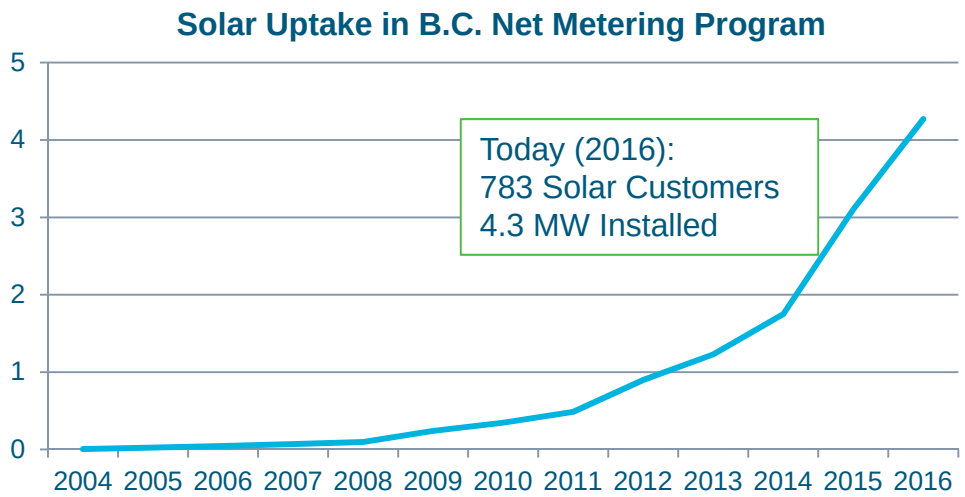
Continue to monitor technology/market development (particularly batteries, solar)

More info on solar:

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

- In B.C., adoption of residential solar in the Net Metering Program has been negligible but is growing
  - Relative to the US, B.C. has a poorer solar resource, lack of financial incentives and higher cost of system installation (nascent market)
  - Projects in the Net Metering Program are mostly solar PV projects

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



2018 IRP – Resource Options Inventory

Explore cost effective clean capacity options
(particularly given Climate Leadership Plan)

- Load curtailment
- Capacity focused DSM program pilot
- Rate design options:
  - Engagement with commercial customers to explore interruptible rate options (BCUC Order)
  - Other optional rate to manage capacity need
- Emerging options:
  - Distributed energy storage
  - Electric Vehicles integration as a resource option

Continue to monitor technology/market development

Results of 2014-2015 Resource Options update to be posted at www.bchydro.com/supplyoptions by mid October

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2018 IRP – Climate Change

Two essential aspects of the climate change dialogue

Mitigation

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

Adaptation

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

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

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2018 IRP – Climate Change

Mitigation

- Driven by government policies such as the Climate Leadership Plan, and legislative and reporting requirements
- Primary contribution includes acquiring DSM and clean supply side resources to meet demand, supporting electrification etc.
- BC Hydro continues to adjust the IRP as necessary to support government policies

Adaptation

- Driven by corporate due diligence and requirements to have an adaptation plan per Climate Leadership Plan
- Climate change impacts & implications for IRP:
  - Changes to water supply and average temperatures can impact resource adequacy (e.g. generation, load)
  - Changes to weather patterns (severity e.g. increased storm events) can impact infrastructure resiliency (e.g. system reliability)
- BC Hydro has been collaborating with Pacific Climate Impacts Consortium (PCIC) on climate/weather modelling to understand climate change impacts:
  - Previous study shows, by 2050, there will be a modest increase in annual water supply, and significant change in runoff timing
- BC Hydro continues to work with PCIC to understand the impact of the updated International Panel on Climate Change (IPCC) emission/climate scenarios, and will advancing the understanding of impacts on our system so to guide our adaptation efforts (to ensure resource adequacy and system resiliency)

2018 IRP – Demand-Side Management

Target beyond 2020

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

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

- A study that estimates the conservation potential of electricity and natural gas consumption over a period of 20 years
- Joint effort between BC Utilities including BC Hydro, FortisBC Electric, FortisBC Gas, and Pacific Northern Gas
- Target to review draft results with CPR Technical Committee in November
- Target to finalize CPR late 2016

Future DSM options

- Will coordinate engagement with IRP TAC and Energy Conservation & Efficiency Committee
- Will discuss assessing uncertainties and flexibility

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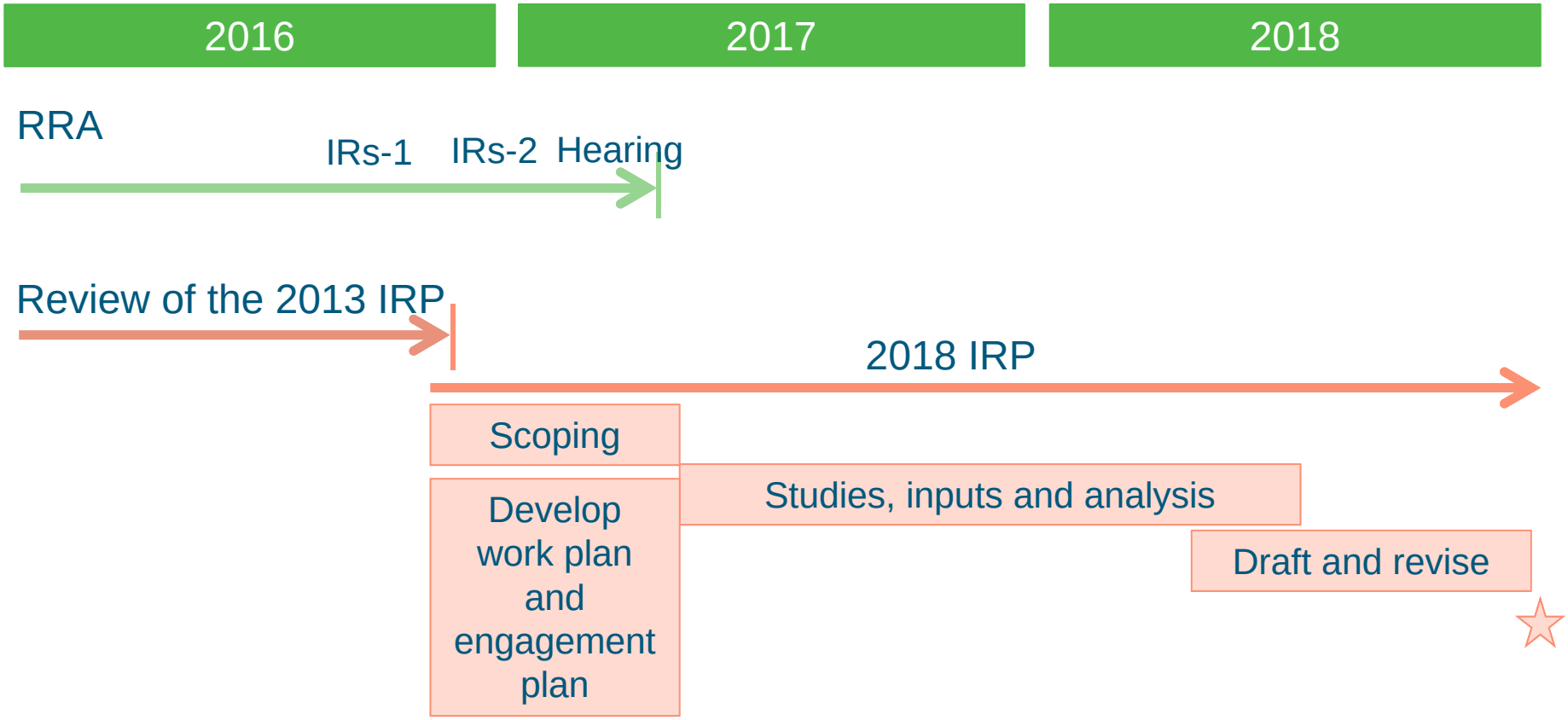
2018 IRP – Timeline & Next Steps



- Next meeting – Spring 2017
- Objective – to review/discuss 2018 IRP draft work plan

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