Integrated Resource Planning

Round Table 16-4

November 16, 2016

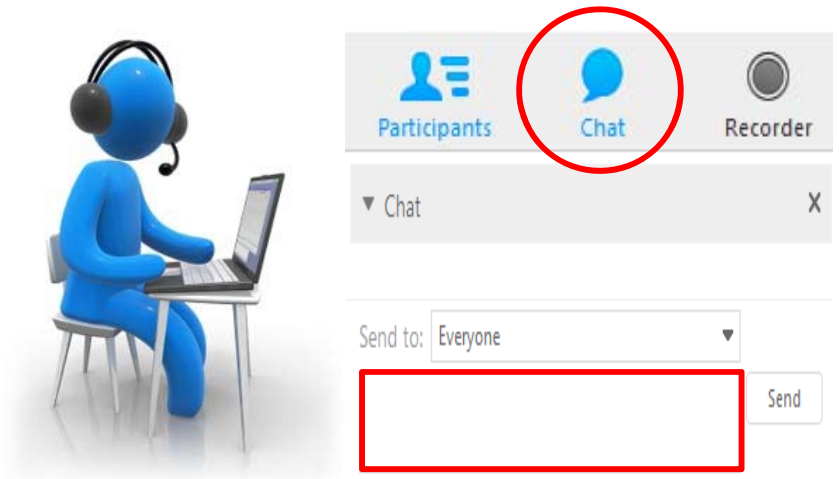
Meeting Logistics

Local Participants:

- World Trade Center facility
- Wireless internet access
- Sign-in sheets

Virtual Participants:

- Ask questions via 'chat' feature
- Meeting will stay open during breaks, but will be muted



- Electronic version of presentation:
  portlandgeneral.com/irp >> Integrated Resource Planning

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Ladder Safety

Check that the ladder is on secure and level ground.

Space the ladder 1 foot away from the wall for every 4 feet high it reaches.

Stay centered between rails and do not overreach.

For roof access, extend the ladder at least 3 feet above the roof.

Keep the ladder clear of obstacles – watch for overhead lines.

Today's Roundtable Topics

9:00a	**Start**
9:00a	Welcome / Safety Moment
9:15a	2016 IRP Process Overview
10:00a	2016 IRP Document
10:30a	**Break (15 minutes)**
10:45a	IRP Results
11:45a	RFP
12:15p	**Lunch (30 minutes)**
12:45p	Market Discussion
1:15p	Technology Discussion
1:45p	**Break (15 minutes)** if needed
2:00p	Smart Grid Report
2:30p	Next steps
3:00p	**Adjourn**

2016 IRP Process Overview

Franco Albi

Stakeholder Engagement

PGE values your engagement

2016 IRP included robust information sharing and stakeholder input

- Nine round tables (public meetings)
- Two public meetings with the OPUC Commissioners
- Responses to over 100 parking lot questions (from meetings)

PGE's mission

Be a company our customers and communities can depend on to provide electric service in a safe, sustainable and reliable manner, with excellent service, at a reasonable price

- Ongoing opportunity for input at: https://www.portlandgeneral.com/forms/pge-stakeholder-feedback

Continuing commitment to clean energy

Current actions avoid ~1.8 million tons of CO_2 per year, increasing to ~10.2 million avoided tons per year in 2040

- Leader in energy efficiency, demand response, smart grid, energy storage
- PGE runs #1 renewable power program
- Further reducing CO_2 by upgrading plant efficiency, enhancing fish passage
- Will stop burning coal at Boardman plant by the end of 2020
- Met 15% RPS for 2015 – 2016 IRP puts us ahead of schedule for meeting 20% by 2020

Sustainability

Woven into the fabric of PGE's values are the sustainability pillars of People, Planet, and Performance

People

- Safety is a core principle
- Investing in our communities
- Engaging with stakeholders

Planet

- Increasing renewables
- Reducing emissions
- Protecting wildlife habitat

Performance

- Maintaining reliability and resiliency
- Increasing efficiency
- Managing fiscal responsibilities

2016 IRP Approach

Continuous improvement and evolution through the 2016 IRP

Incorporate changing policy

- Federal Clean Power Plan
- Western Energy Imbalance Market
- Oregon Clean Electricity Plan (SB 1547)

Commitment to rigorous analysis

- Load Forecast methodology
- Resource Adequacy methodology
- Integration of all resources
  - Resource potential studies
  - Flexibility analysis
  - Energy Storage analysis

Adaptive Action Plan

- Minimize greenhouse gas emissions
- Maintain Resource Adequacy
- Maximize resource options

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Three integrated components to deliver sustainability

Energy Management

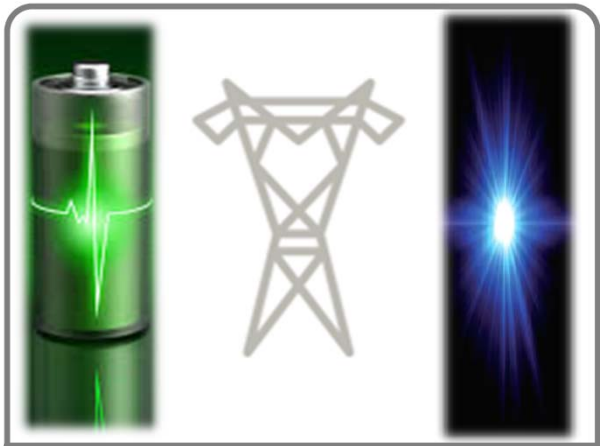
Cost-effective Energy Efficiency

Increasing Demand Response

Wind, Solar, Hydro, Biomass, Geothermal

Renewable Expansion

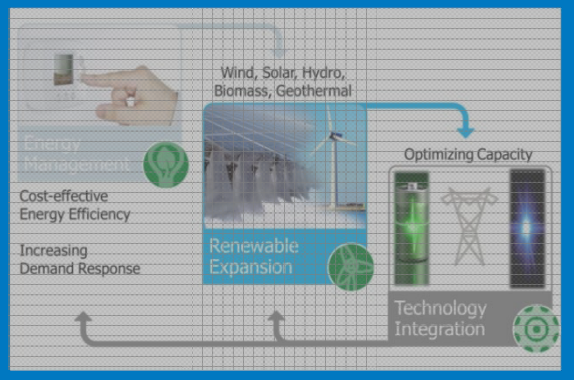
Optimizing Capacity

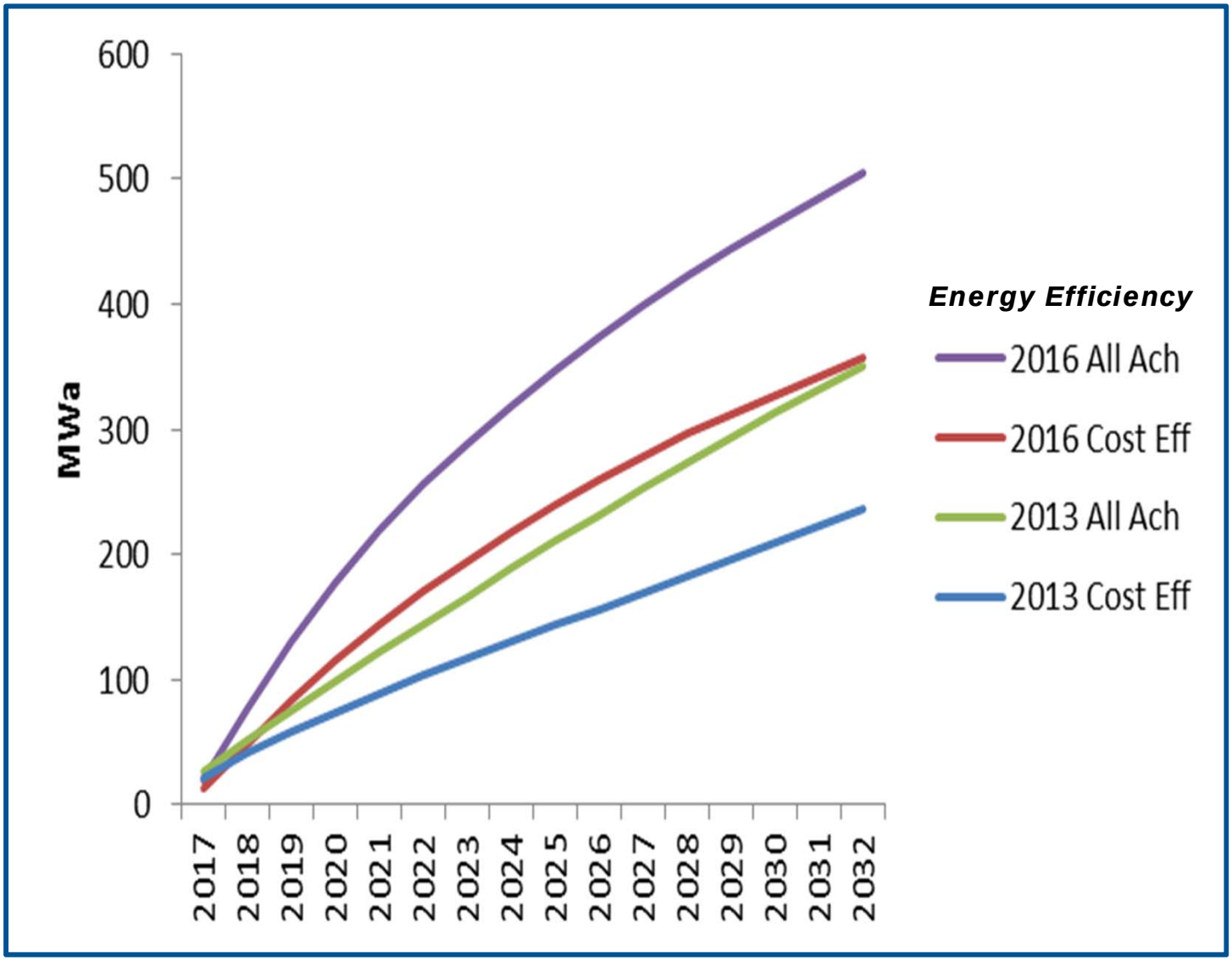


Technology Integration

Energy Management

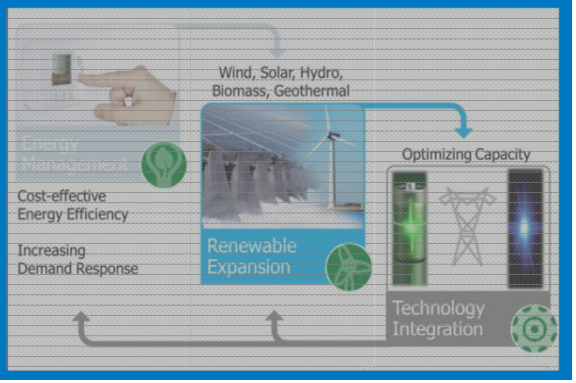
PGE's 2016 IRP targets greater Energy Efficiency and Demand Response

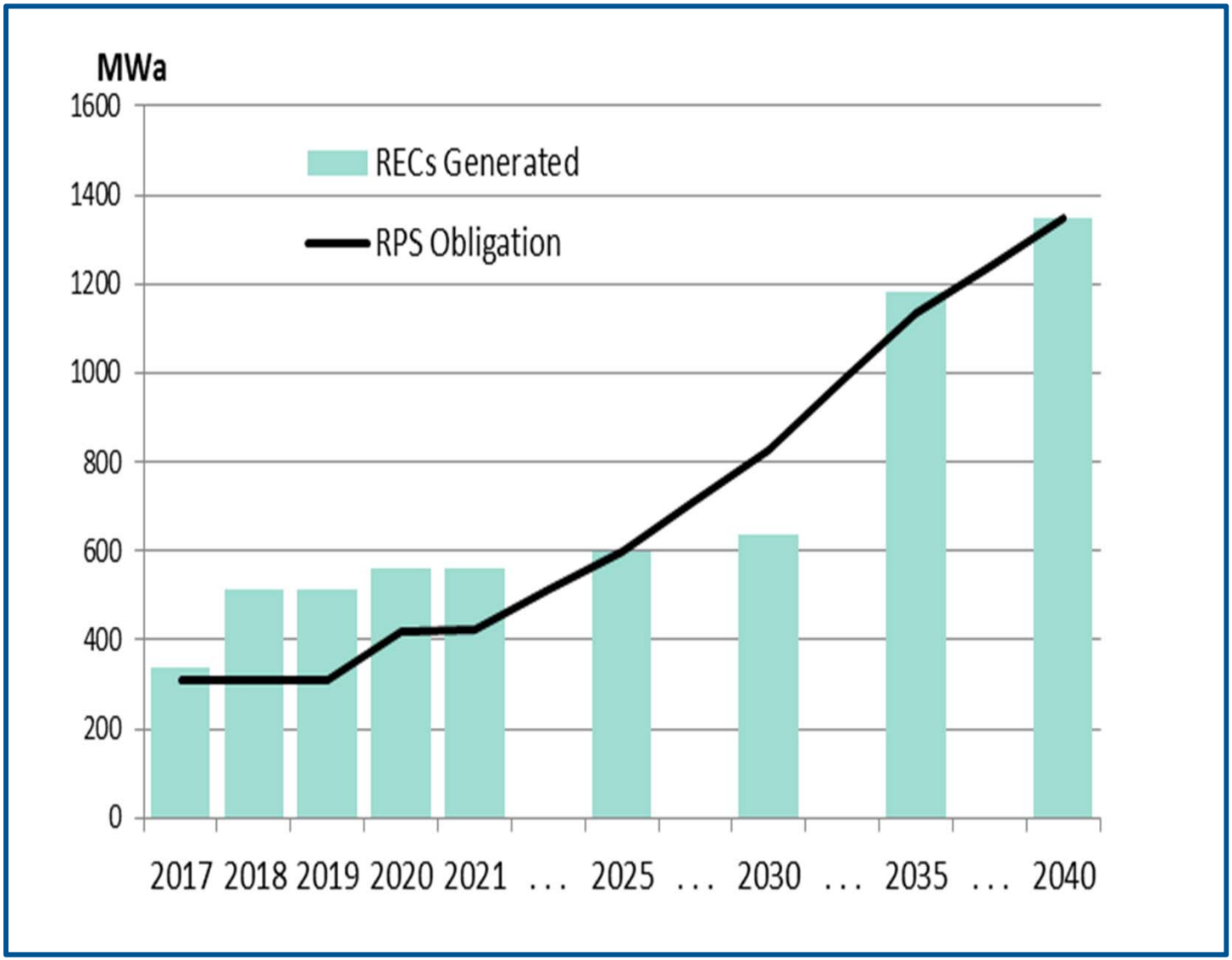




Renewable Expansion

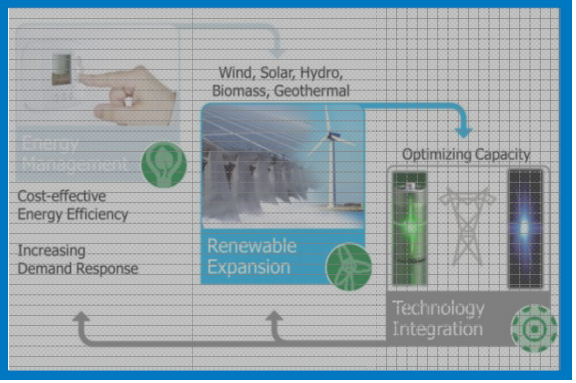
PGE's 2016 IRP recommends substantially exceeding 2020 RPS targets based on economics and risk reduction

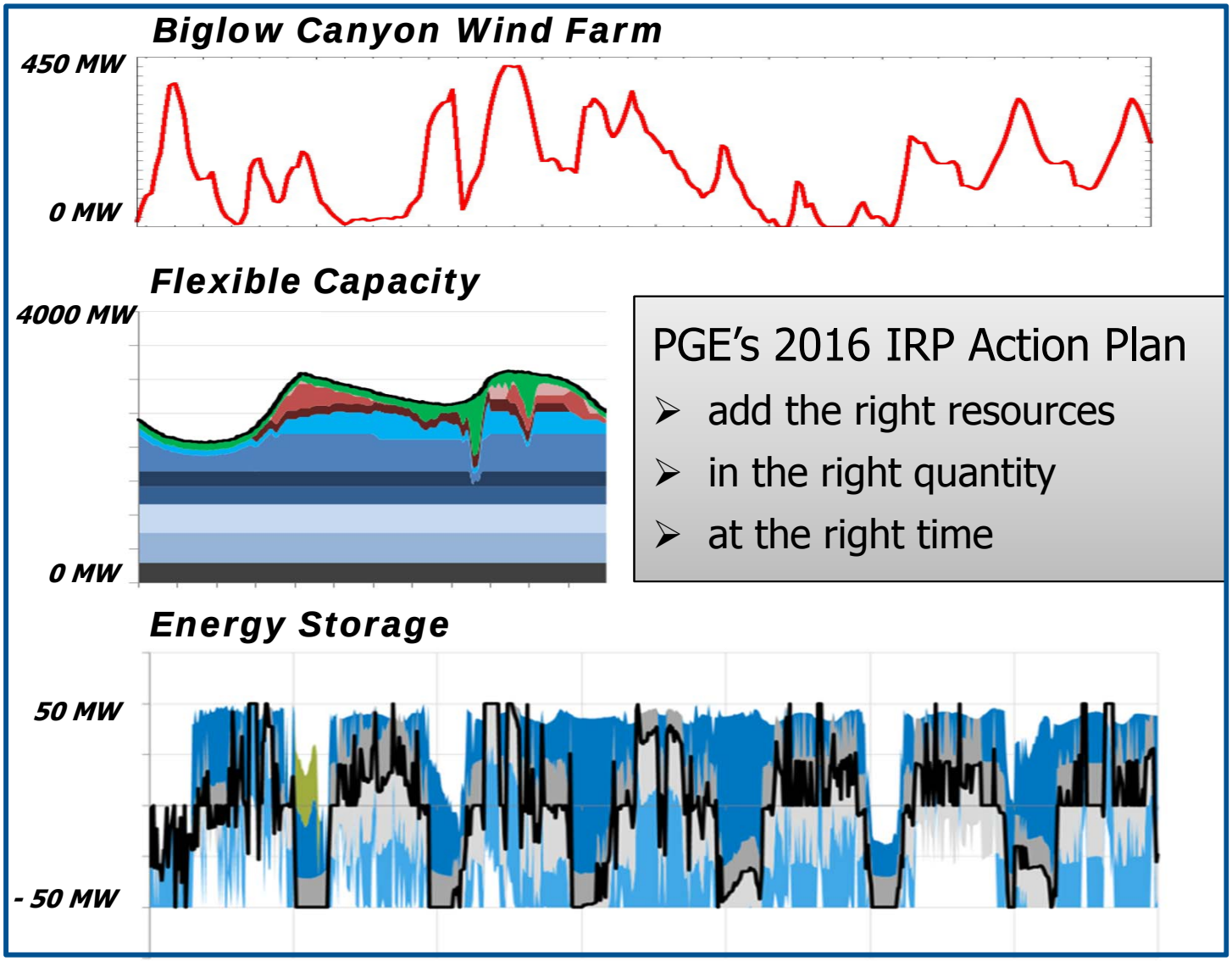




Technology Integration

PGE's 2016 IRP integrates technology to accelerate a reliable, affordable transition



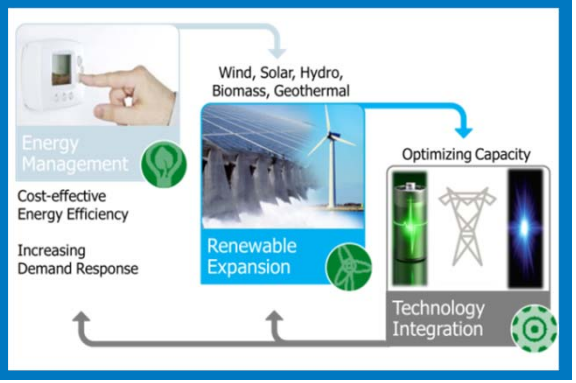


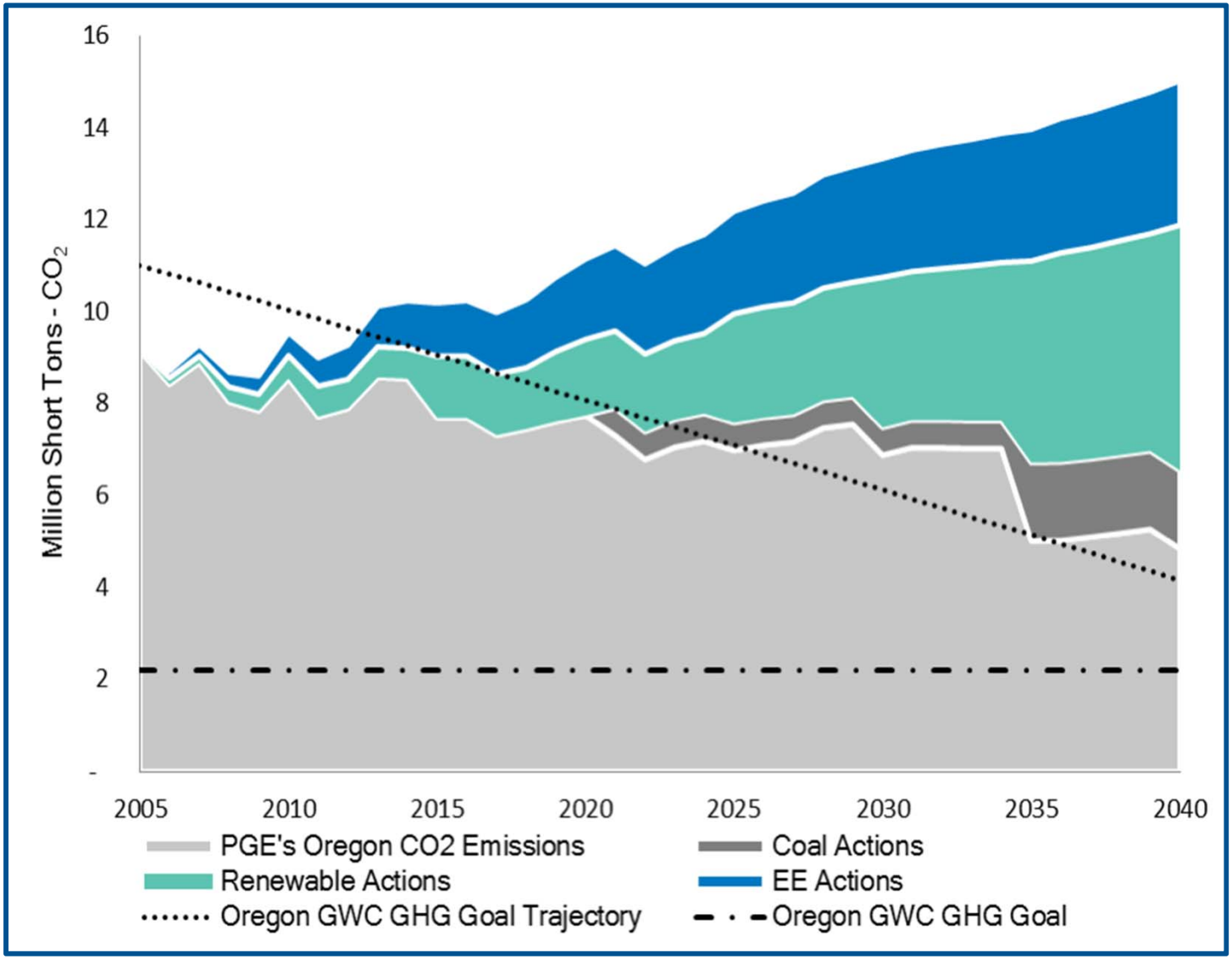
PGE's 2016 IRP Action Plan

- add the right resources
- in the right quantity
- at the right time

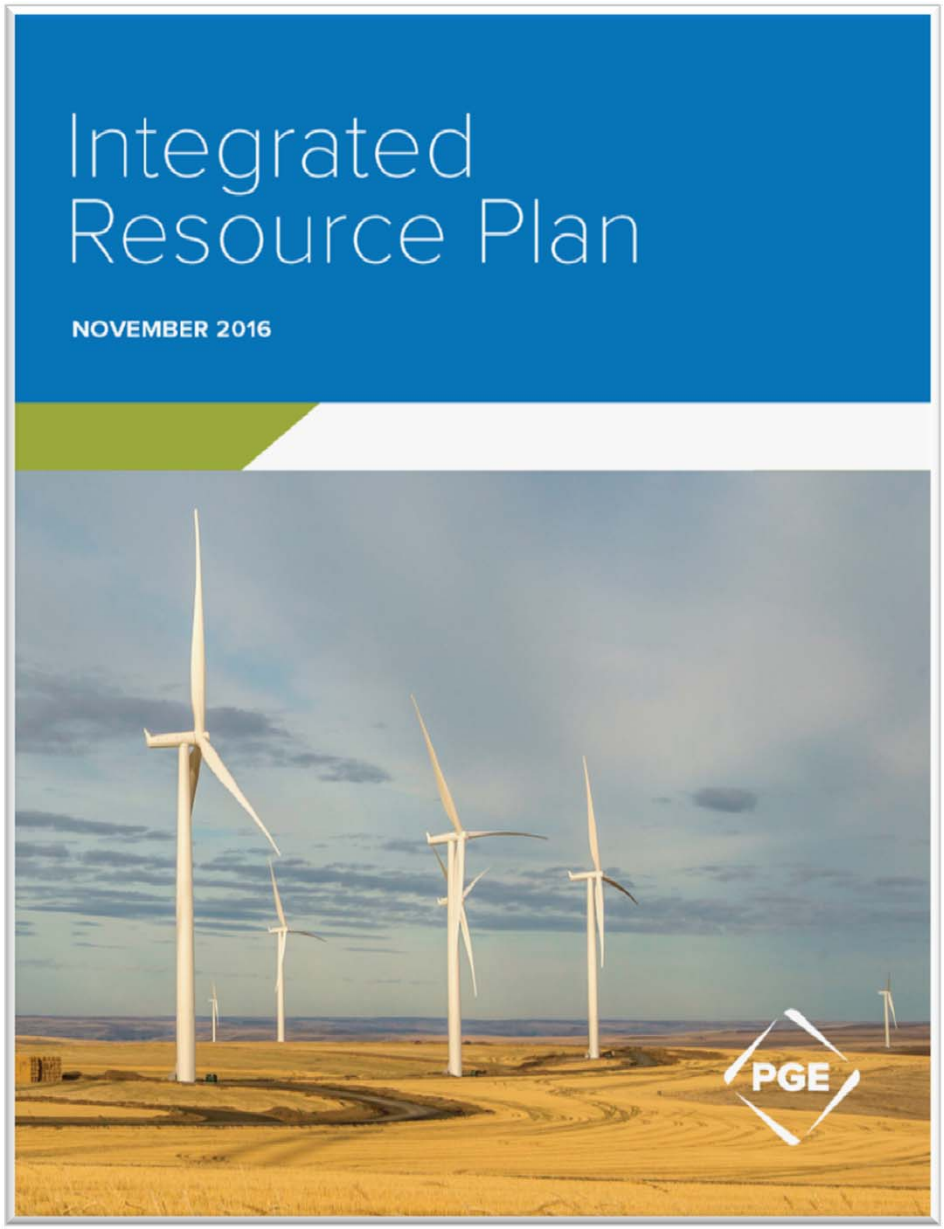
Reducing CO_2

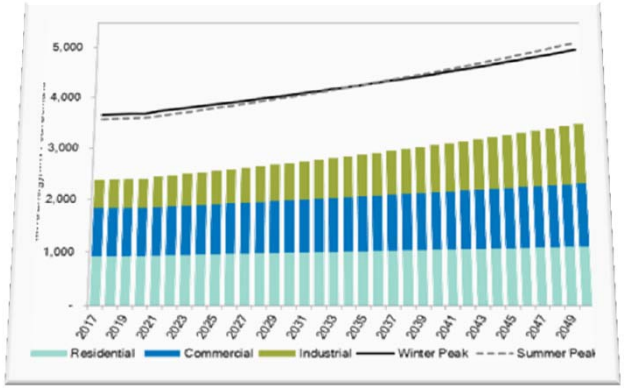
PGE's 2016 IRP forecasts CO_2 reductions consistent with SB 1547 estimates



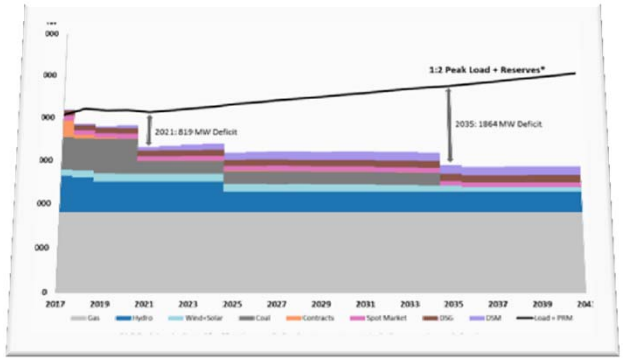


Executive Summary





Load



Need

Keys

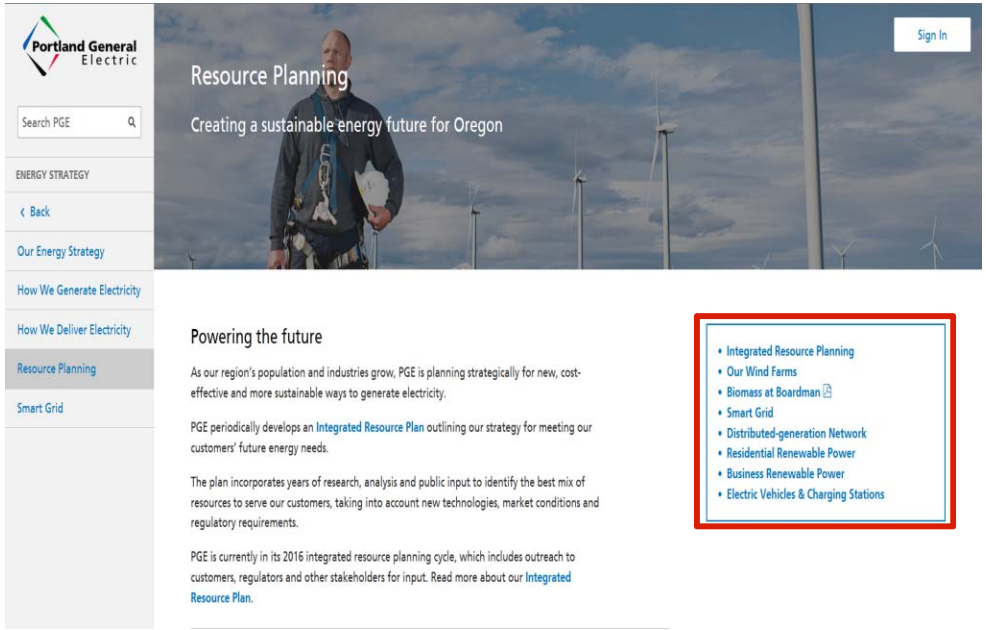
1. Energy Efficiency and Demand Response are foundational
2. Production Tax Credits can reduce costs to customers
3. Acquisition of flexible resources maintains reliability
4. Integrated portfolios perform relatively better

2016 IRP Document Overview

Franco Albi
Elaine Hart

Exploring the IRP – Downloading

www.portlandgeneral.com/irp



- Integrated Resource Planning
- Our Wind Farms
- Biomass at Boardman
- Smart Grid
- Distributed-generation Network
- Residential Renewable Power
- Business Renewable Power
- Electric Vehicles & Charging Stations

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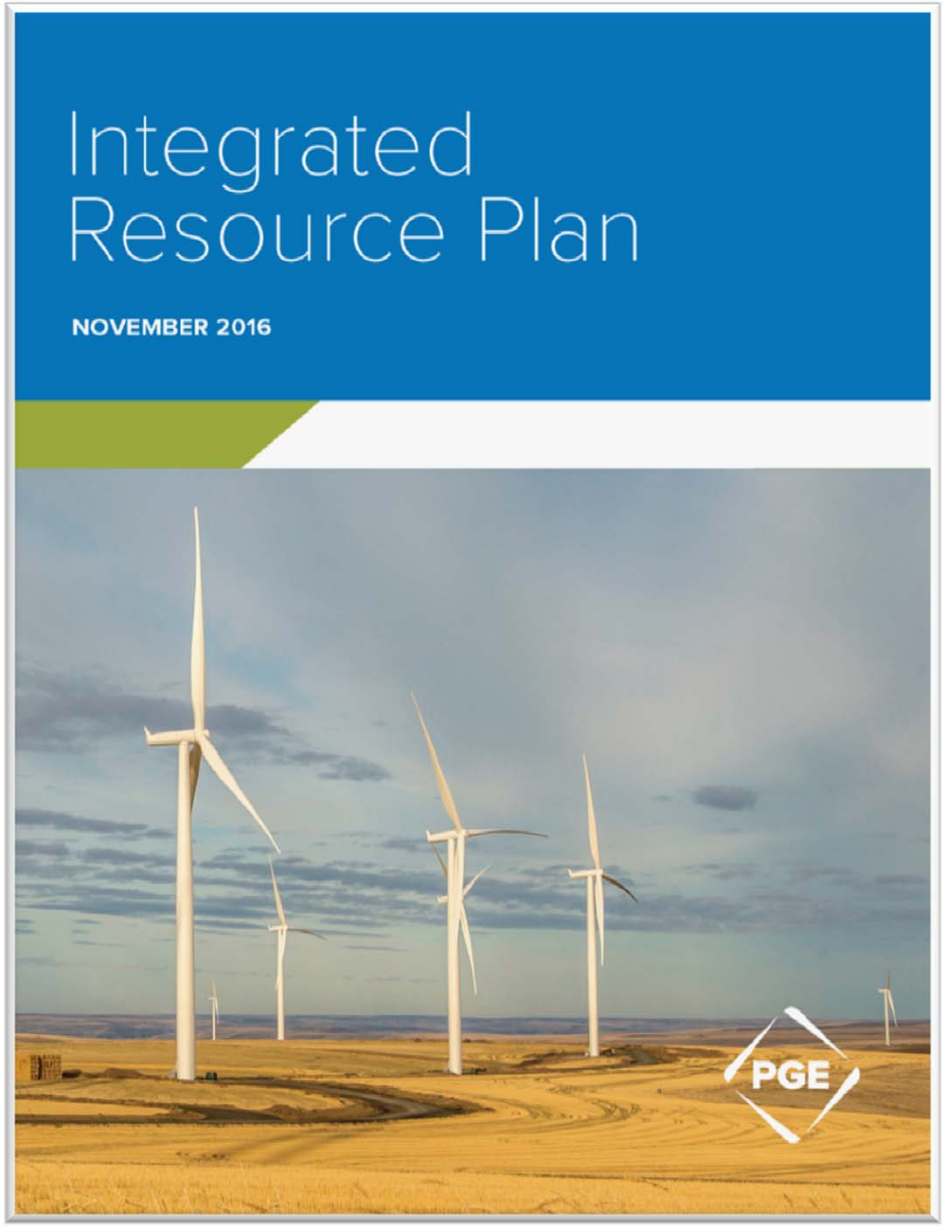
Search PGE

SCROLL DOWN TO 2016 IRP

2016 IRP

- PGE's 2016 Integrated Resource Plan (November 15, 2016)
- PGE's 2016 Integrated Resource Plan - Executive Summary (November 15, 2016)

Exploring the IRP – Structure



2 Volumes	13 Chapters
5 Parts	17 Appendices

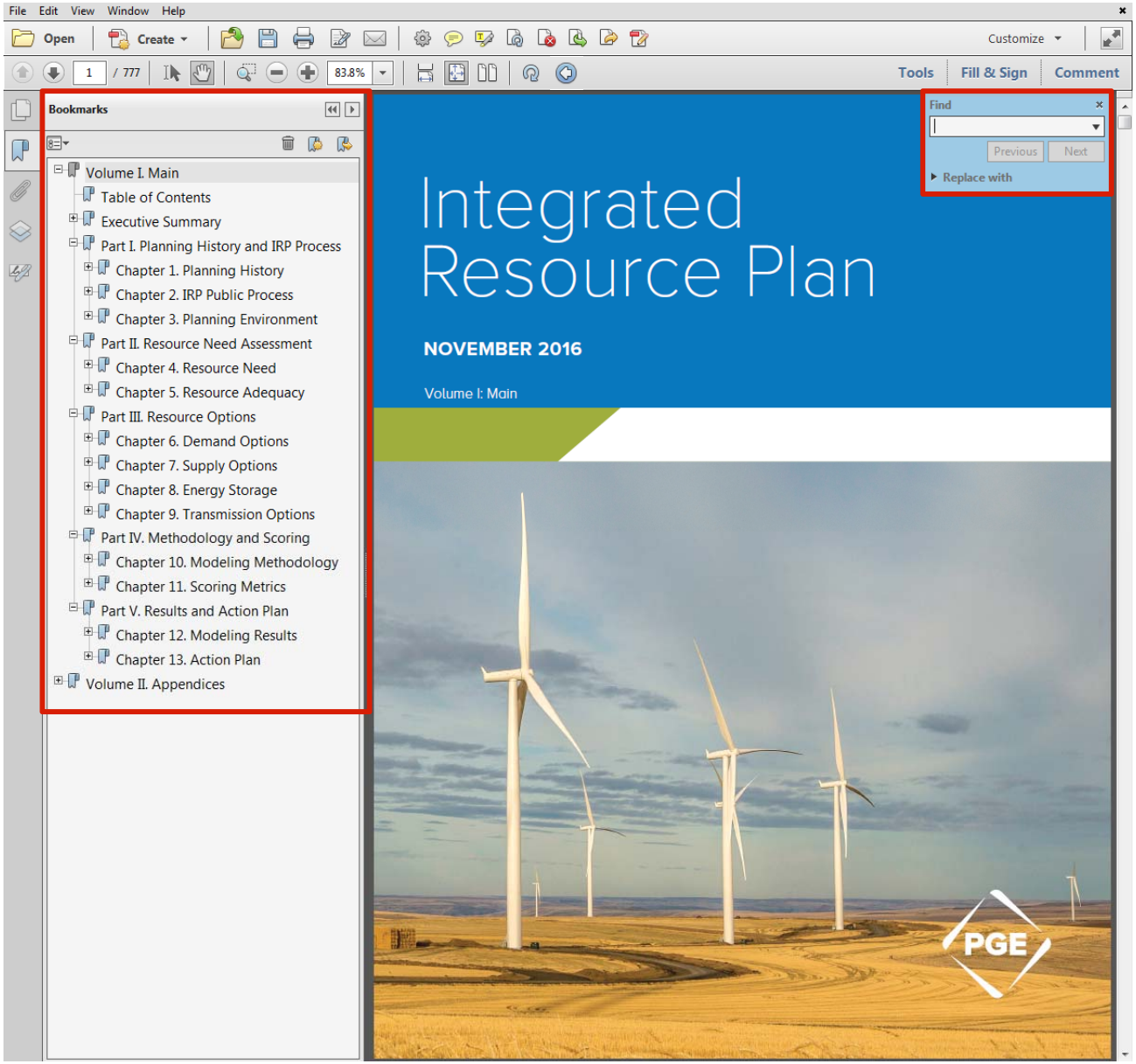
Volume I. Main

0. Executive Summary
1. Planning History
2. IRP Public Process
3. Planning Environment
4. Resource Need
5. Resource Adequacy
6. Demand Options
7. Supply Options
8. Energy Storage
9. Transmission Options
10. Modeling Methodology
11. Scoring Metrics
12. Modeling Results
13. Action Plan

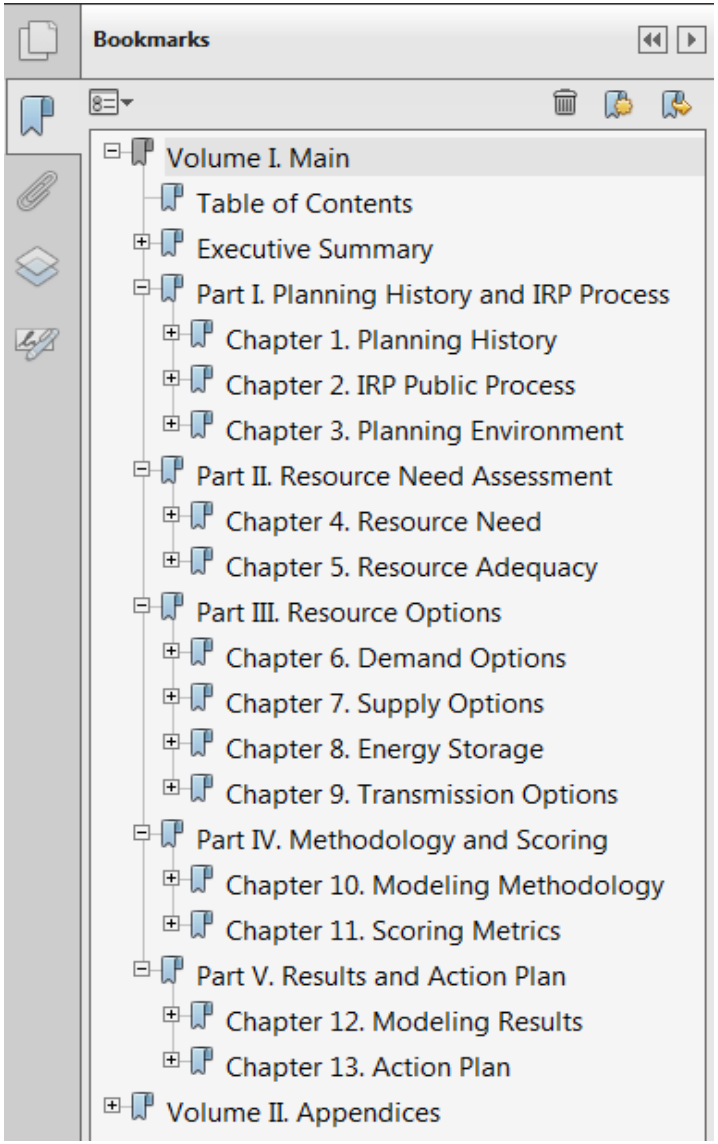
Volume II. Appendices

A. Guideline Compliance
B. Order Compliance
C. Public Process Agendas
D. Existing Resources
E. Climate Change Projections
F. Distributed Generation Studies
G. Dispatchable Standby Gen
H. Market Prices
I. Demand Response Programs
J. CHP Potential Assessment
K. Supply-side Options
L. Futures Analysis
M. Renewable Options
N. WECC Resource Expansion
O. Portfolio Detail
P. Load Resource Balance
Q. Natural Gas Reserves

Exploring the IRP – Navigation



Side Bar Navigation



Exploring the IRP – Chapter Navigation

6.3.1 Demand Response Potential

A detailed discussion of PGE's current firm and non-firm DR programs is available in Appendix I, *Demand Response Programs*.

6.3.1 Demand Response Potential

As a result of the growing interest from stakeholders, other regional entities commissioned several new studies to explore the potential for DR. For instance, in 2014, the Northwest Power and Conservation Council (NPCC) completed a study to assess the market for various flexible load resources.[126] In that same year, PacifiCorp completed a detailed demand-side management (DSM) potential study spanning all of its jurisdictions, with substantial attention focused on DR programs.[127] The Commission noted PacifiCorp's study for the considerable role that demand-side resources will play in future resource planning efforts. Several demonstration projects and pilot studies are now underway in the region and include the involvement of PGE, the Bonneville Power Administration (BPA), Pacific Northwest National Laboratory (PNNL), and many regional utilities.

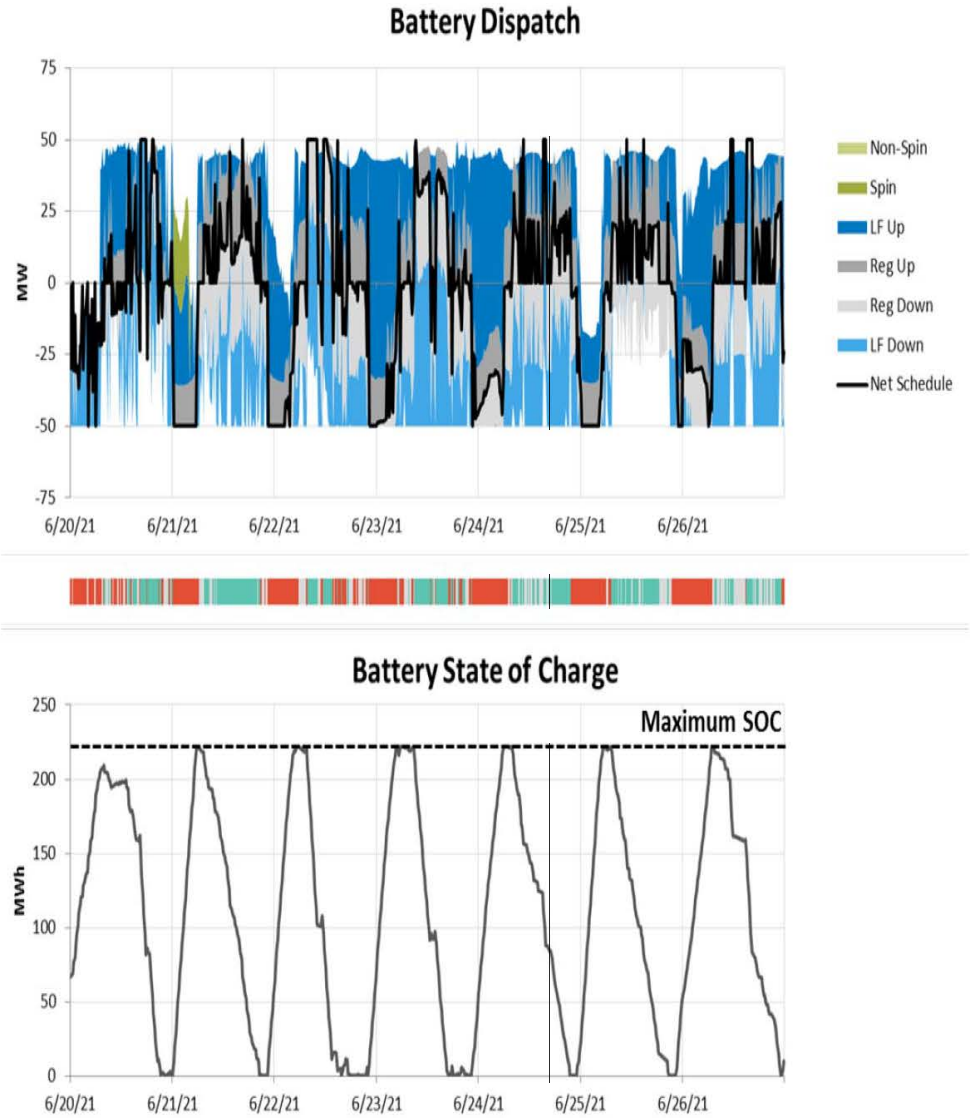
APPENDIX I. DEMAND RESPONSE PROGRAMS

PGE targets DR programs that provide firm, cost-effective capacity that addresses the conditions specific to the Company's service territory. PGE is endeavoring to go beyond DR that is primarily about maintaining reliability during infrequent peaking events or generation outage events to DR that is fast-acting and flexible, and preferably automated. The Company's DR programs include strict specifications designed to meet both types of needs. These specifications also help create programs with greater certainty during curtailment events.

Exploring the IRP – Figure/Table Navigation

Figures

Figure 8-8: Simulated battery (50 MW/4-hr)



Exploring the IRP – Appendix O

Portfolio 3: Efficient Capacity 2021

This portfolio is equivalent to *Portfolio 2 - RPS Wind 2018*, with a portion of the generic capacity in 2021 replaced by a resource with higher fixed costs and a lower heat rate. PGE models the efficient capacity resource as a natural gas-fired CCCT with an average annual capacity of approximately 389 MW. This portfolio allows PGE to assess the potential costs/benefits of relying on a low-heat rate resource to meet capacity needs.

TABLE O-4: Portfolio 3 cumulative resource additions, capacity (MW)

Resource	2017	2018	2019	2020	2021	...	2025	...	2030	...	2035	...	2040
Energy Efficiency	16	61	104	144	180		297		404		490		571
DSG	4	9	13	17	22		30		39		48		57
DR	26	29	31	69	77		162		187		198		198
CVR	-	0.4	0.9	1.3	1.8		3.7		6.3		9.3		12.5
PNW Wind	-	515	515	515	515		628		755		2,511		3,074
MT Wind	-	-	-	-	-		-		-		-		-
Solar	-	-	-	-	-		-		-		-		-
Geothermal	-	-	-	-	-		-		-		-		-
Biomass	-	-	-	-	-		-		-		-		-
Efficient Capacity	-	-	-	-	389		389		389		389		389
Generic Capacity	-	290	318	318	386		697		877		1,310		1,563

FIGURE O-5: Portfolio 3 cumulative resource additions, capacity (MW)

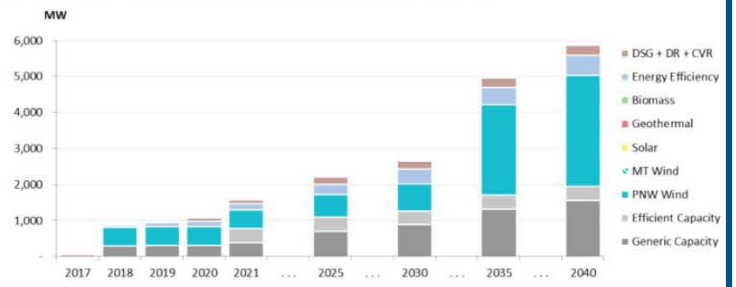
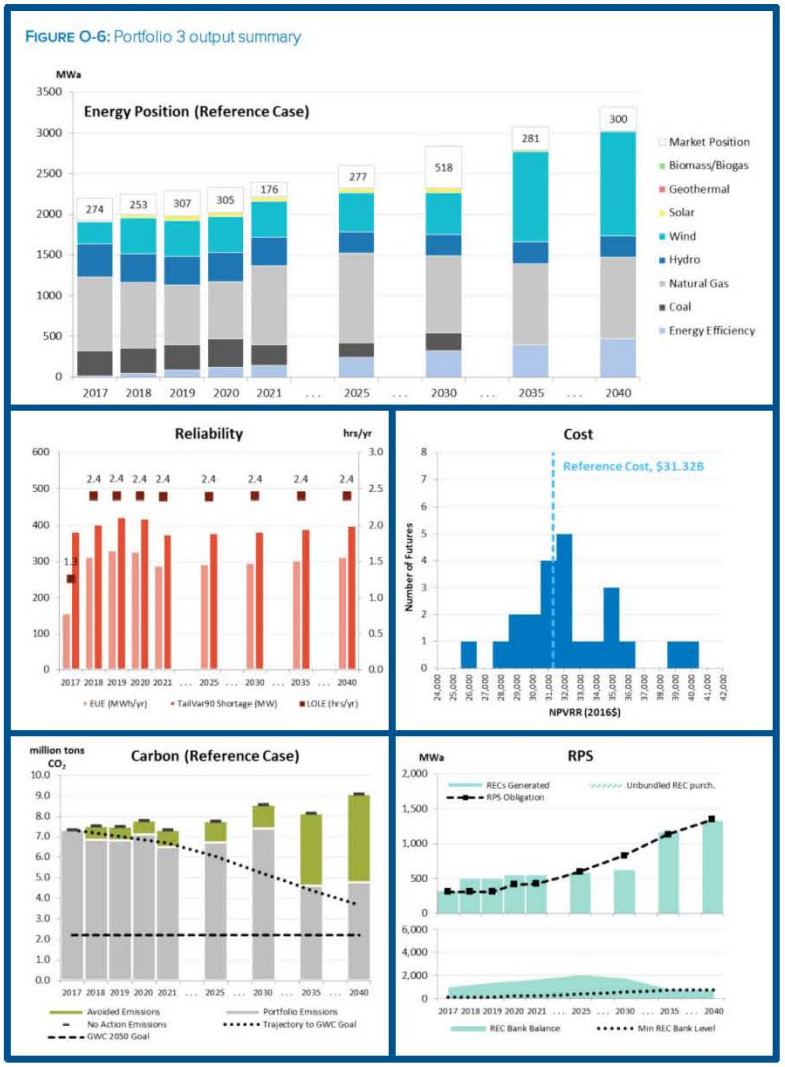


FIGURE O-6: Portfolio 3 output summary



Exploring the IRP – Appendix O

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PNW Wind	-	515	515	515	515		628		755		2,511		3,074
MT Wind	-	-	-	-	-		-		-		-		-
Solar	-	-	-	-	-		-		-		-		-
Geothermal	-	-	-	-	-		-		-		-		-
Biomass	-	-	-	-	-		-		-		-		-
Efficient Capacity	-	-	-	-	389		389		389		389		389
Generic Capacity	-	290	318	318	386		697		877		1,310		1,563

Exploring the IRP – Appendix O

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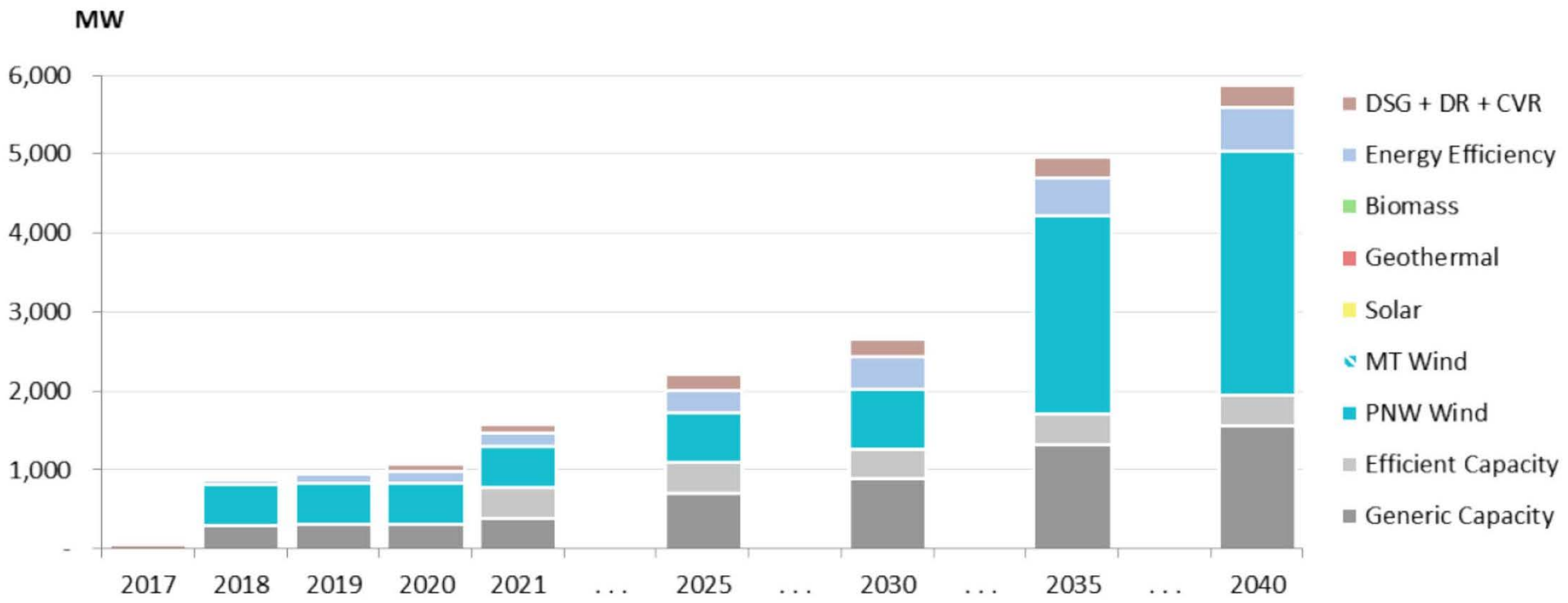

Exploring the IRP – Appendix O

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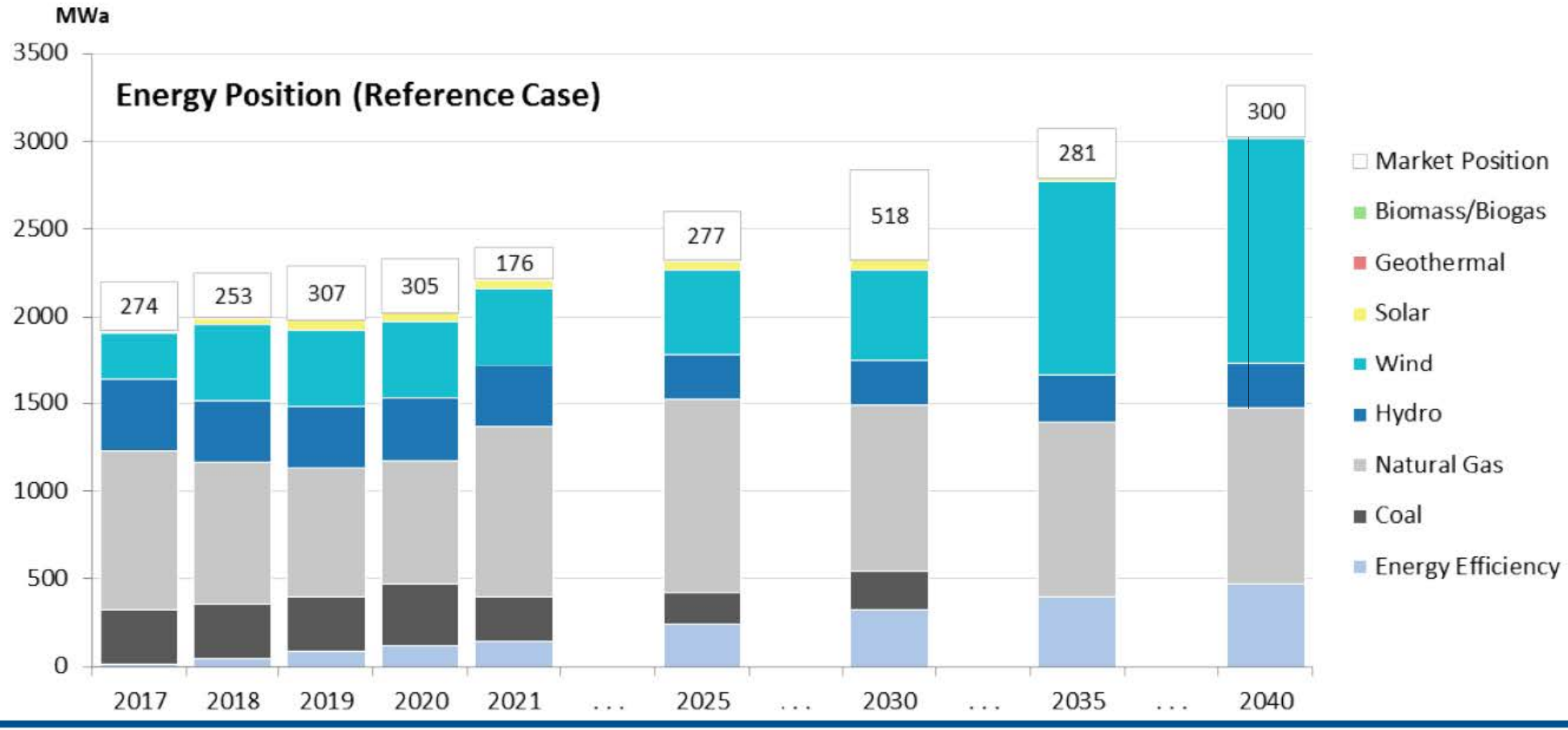
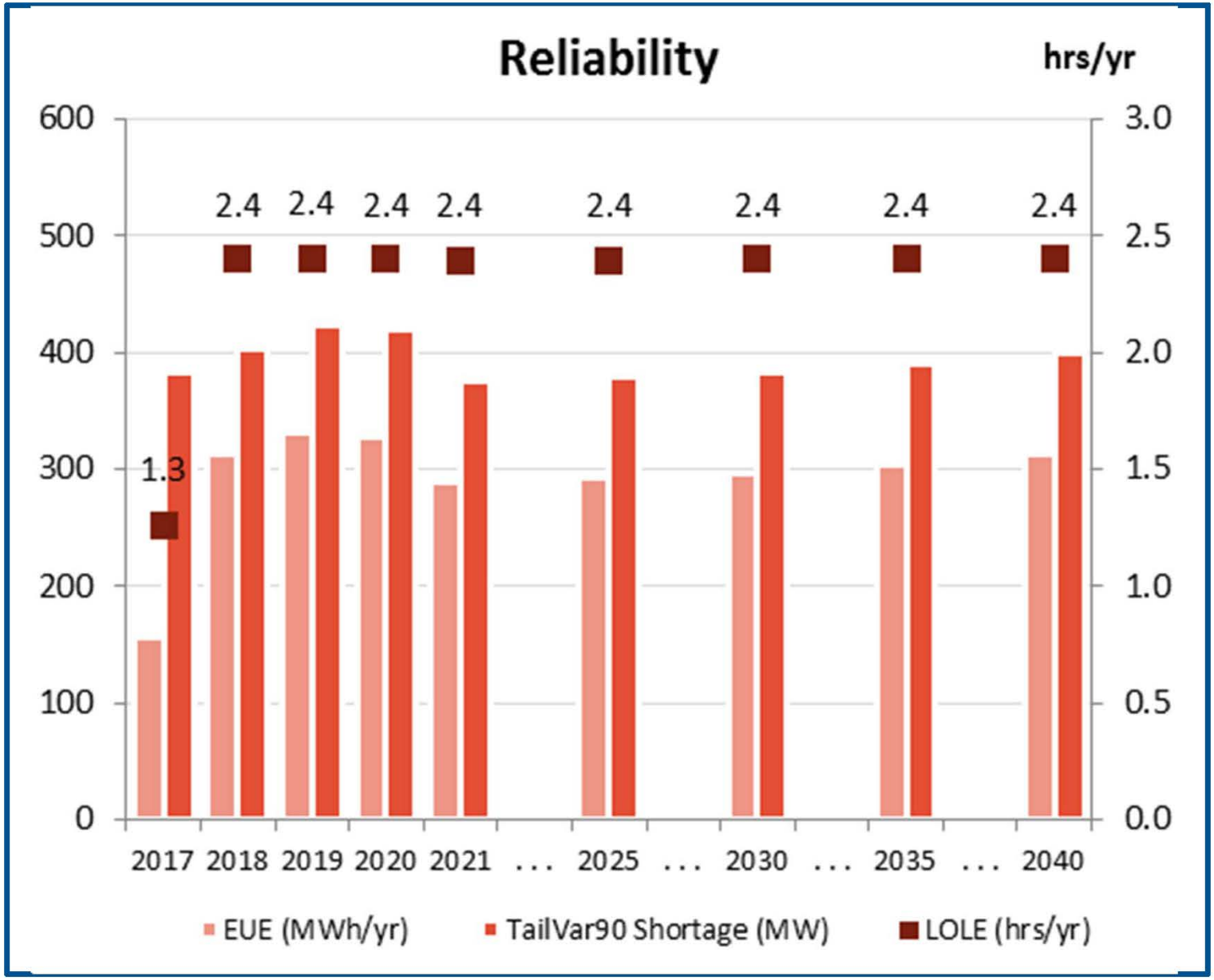
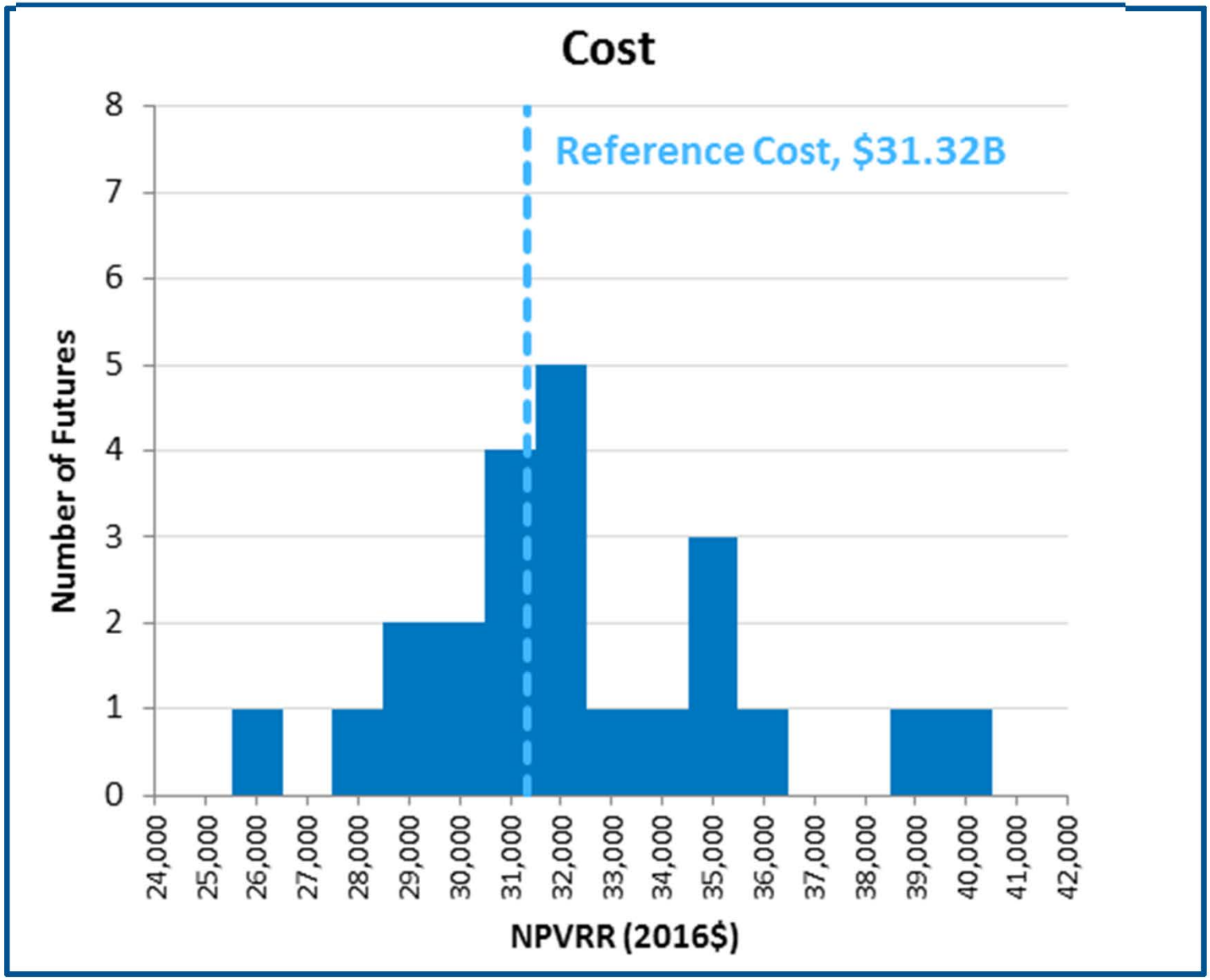


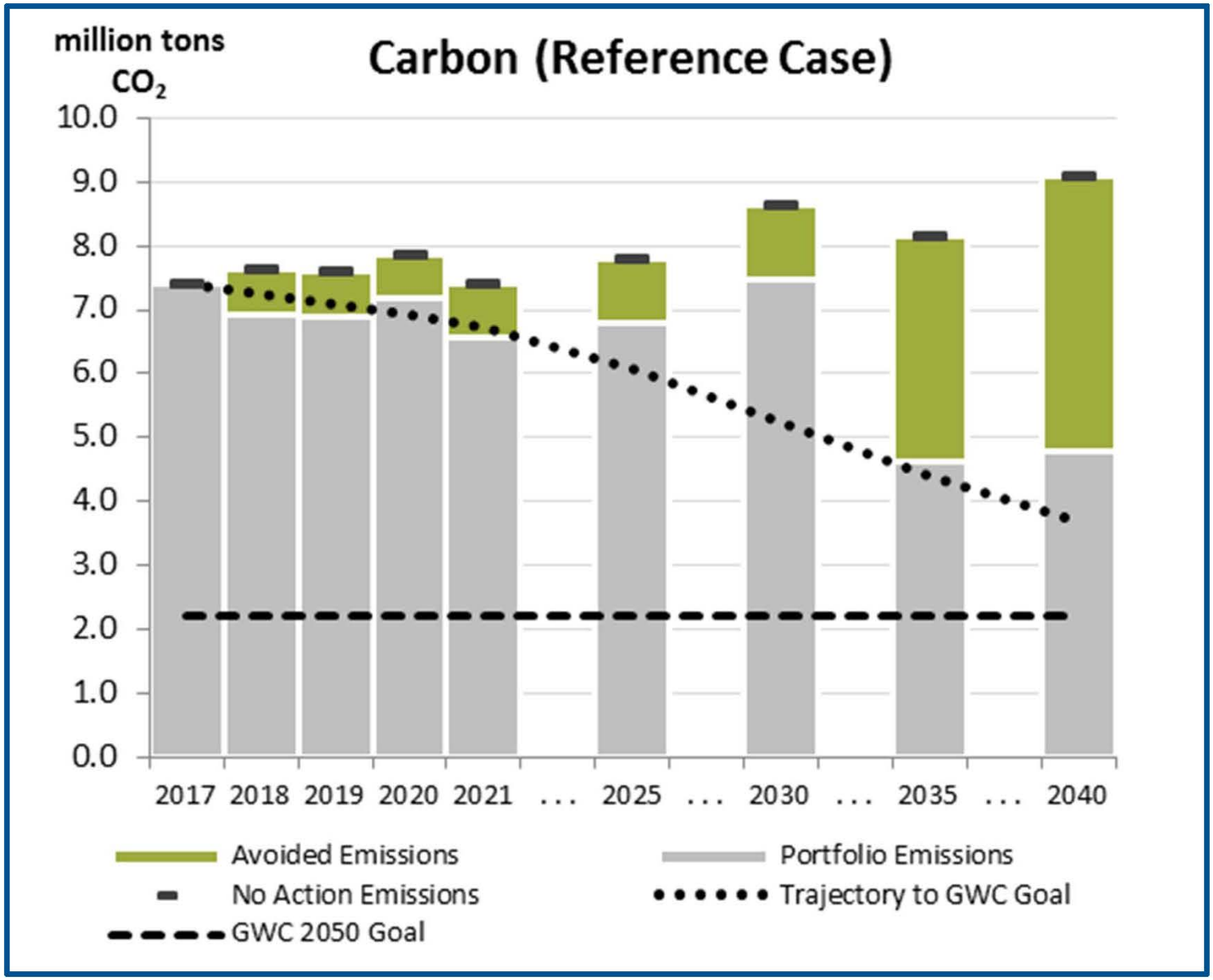
Exploring the IRP – Appendix O



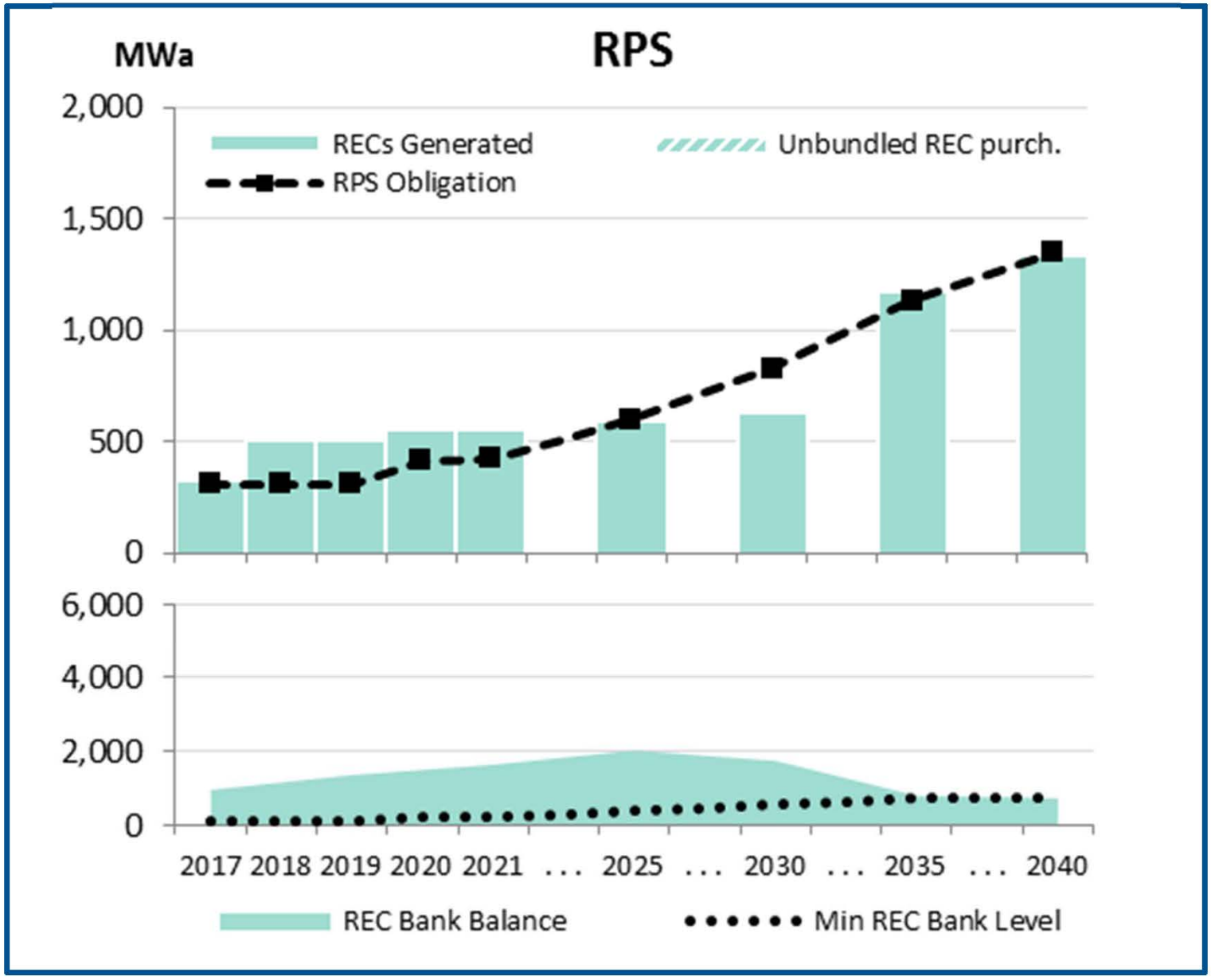
Exploring the IRP – Appendix O



Exploring the IRP – Appendix O



Exploring the IRP – Appendix O

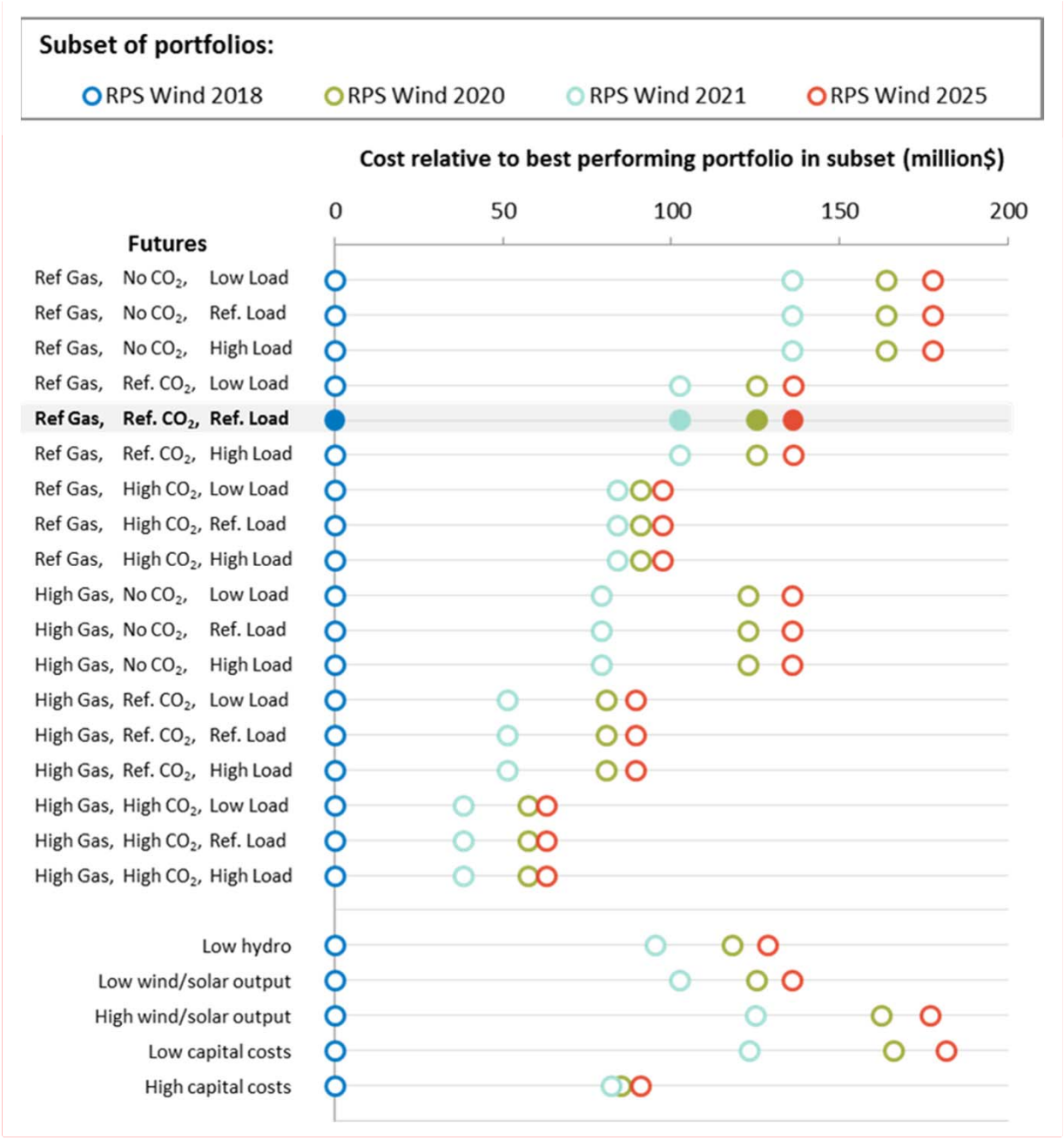


IRP Results

Robert Brown

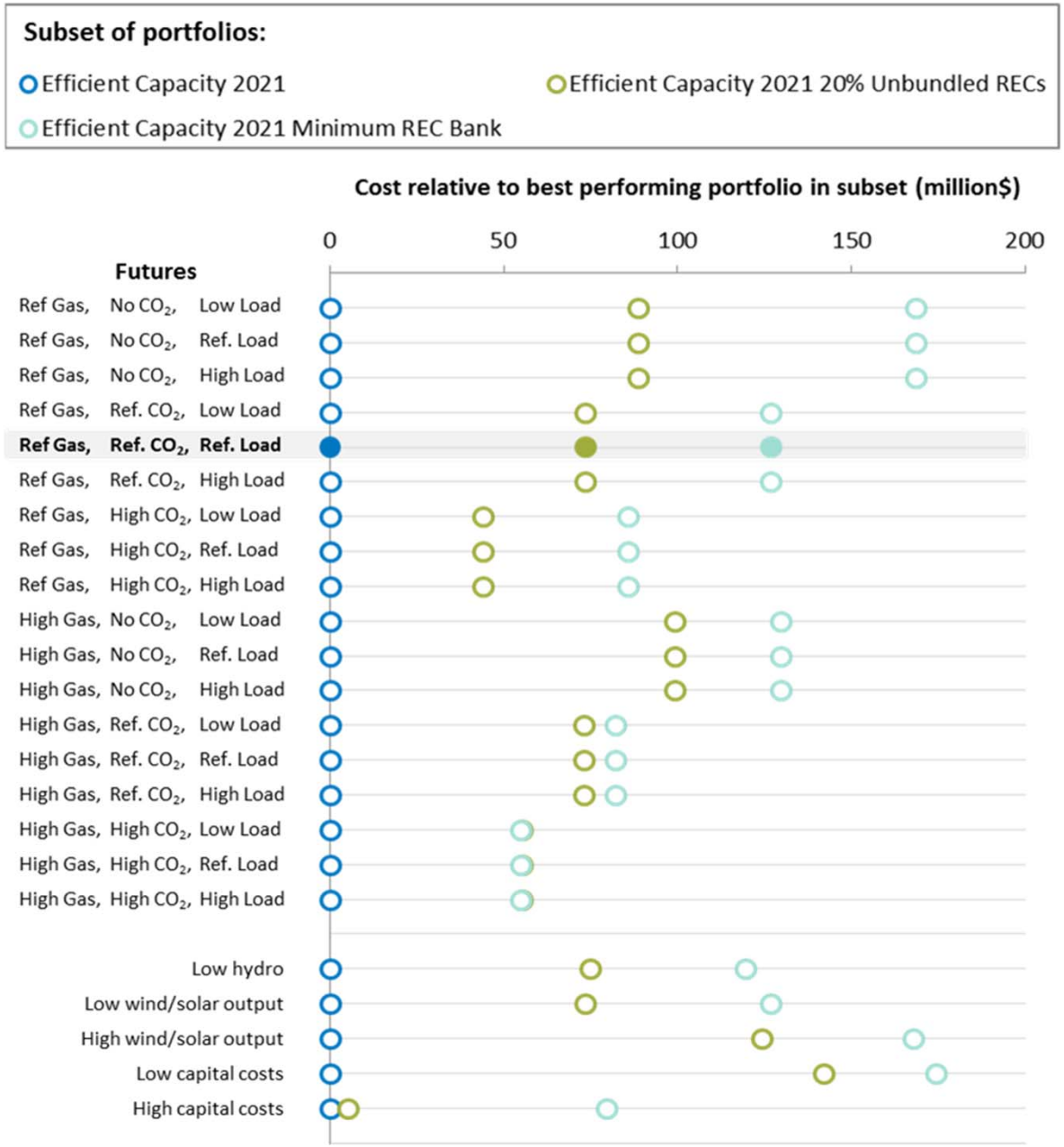
Portfolio Analysis Findings – RPS timing

RPS Wind 2018 (100% PTC) **performance is robust across futures relative to delayed physical compliance**



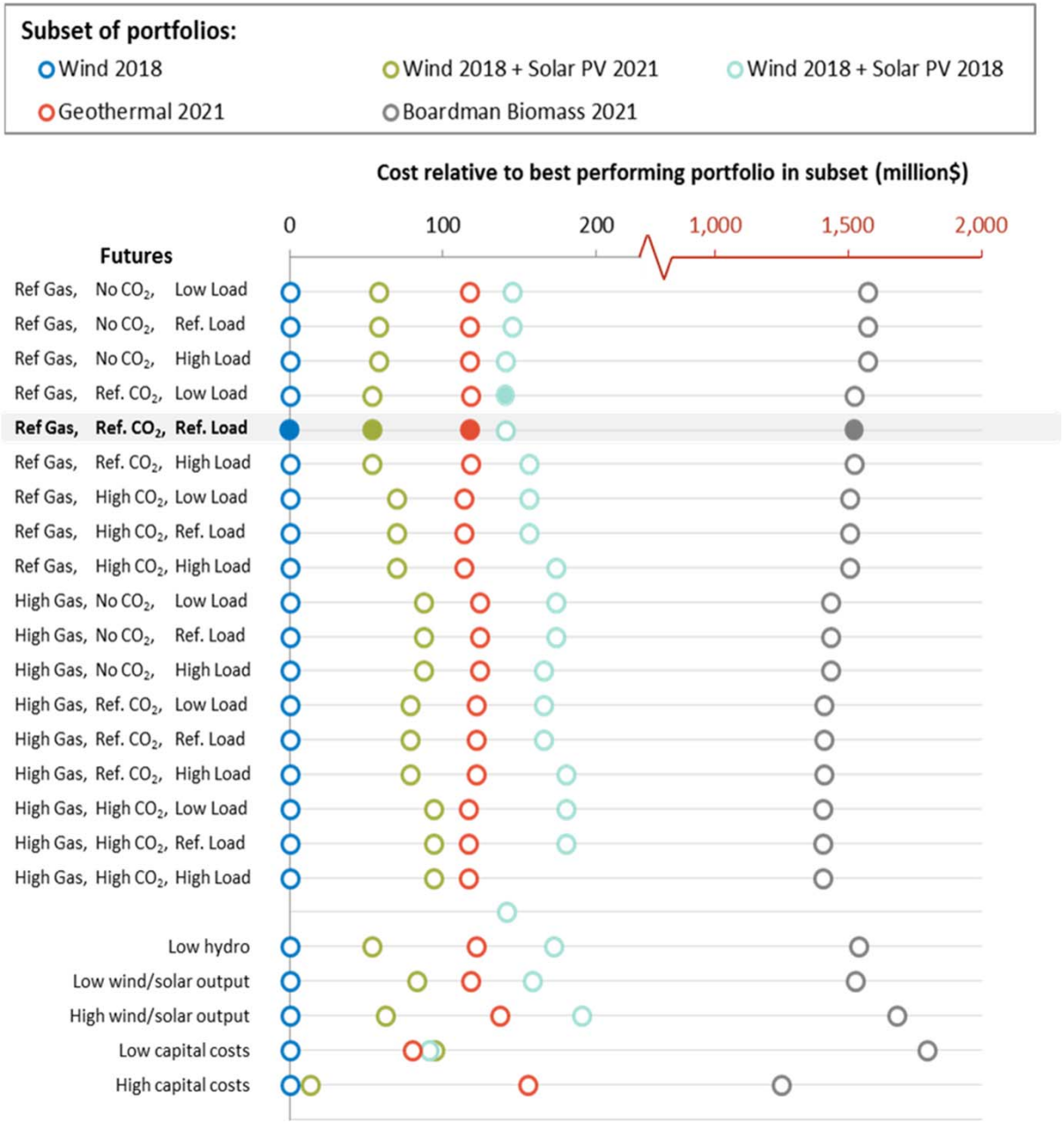
Portfolio Analysis Findings – Banked and Unbundled RECs

100% PTC RPS procurement (*Efficient Capacity 2021* portfolio) is lowest cost across futures relative to reliance on REC bank or reliance on unbundled RECs

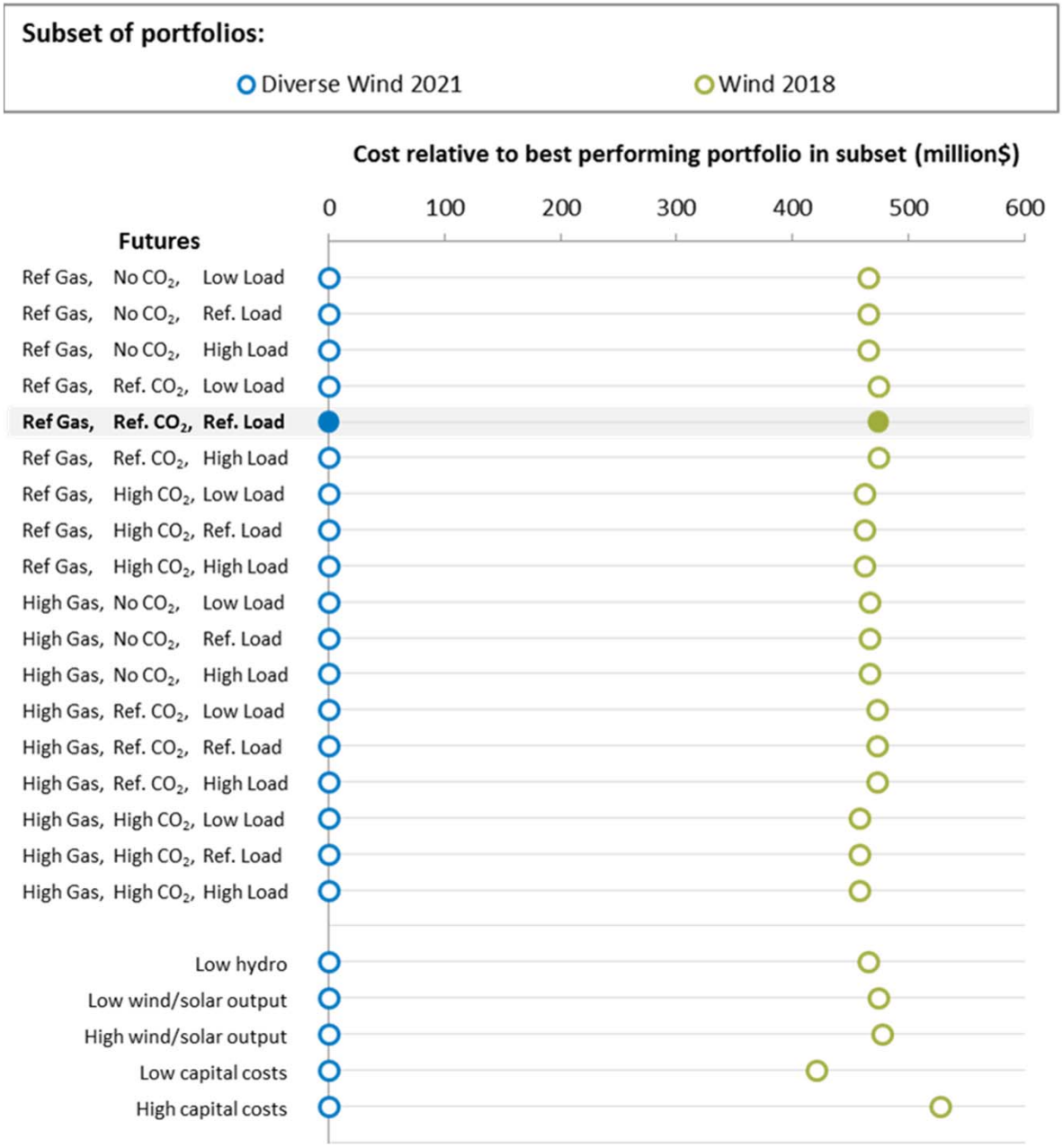


Portfolio Analysis Findings – RPS resource type

Modeled wind resources are lower cost than other renewable resource options



Portfolio Analysis Findings – Diverse Wind

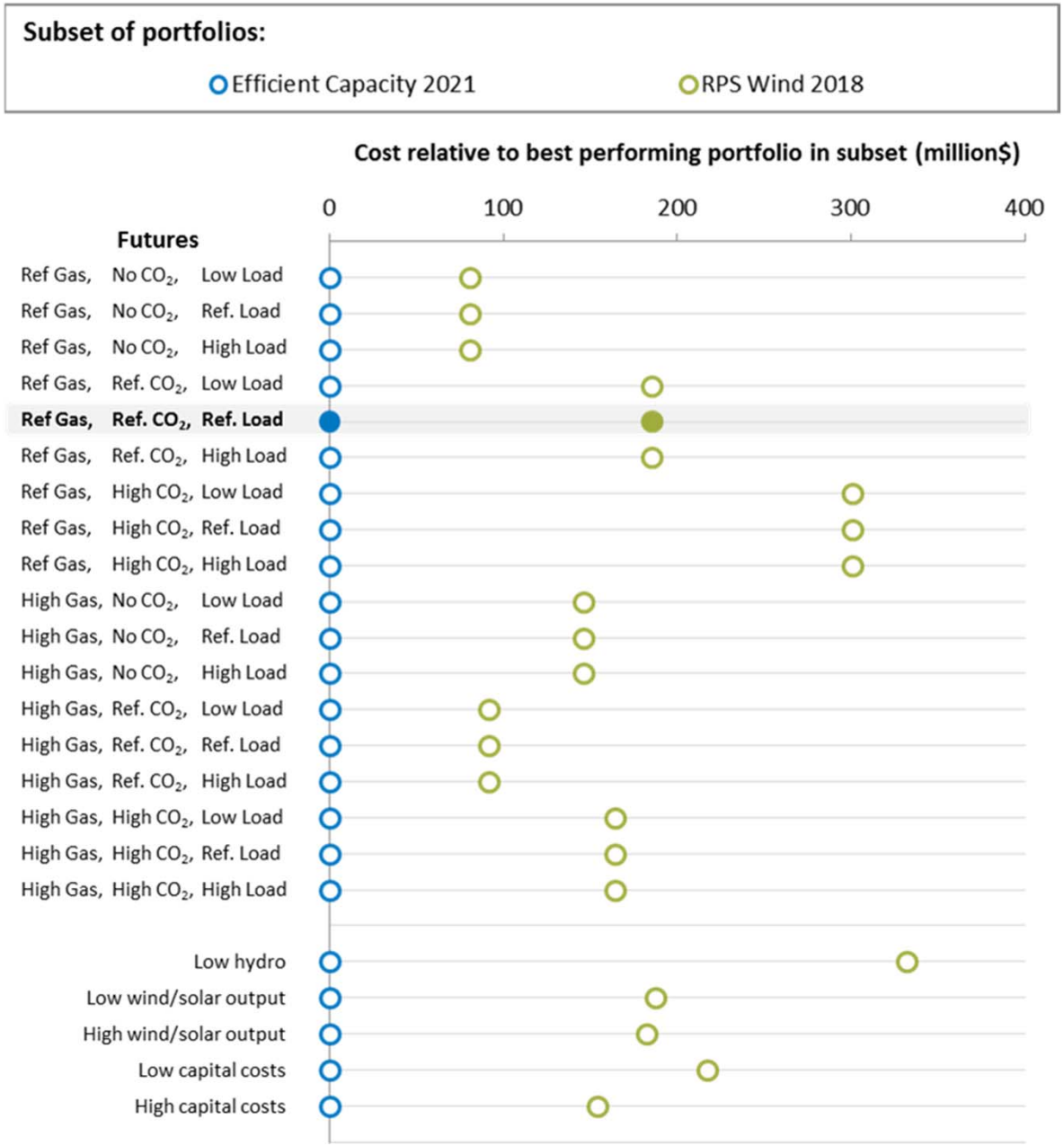


Wind 2018	Diverse Wind 2021
$ 31,652	$ 31,178

Benefit of Montana wind is robust across futures

Findings suggest a transmission budget of approximately $65 per kW-year for a 42% capacity factor Montana wind resource

Portfolio Analysis Findings – Efficient versus low capital cost capacity



RPS Wind 2018	Efficient Capacity 2021
$ 31,504	$ 31,319

Meeting remaining capacity needs with efficient capacity resources is lower cost than meeting capacity needs with low capital cost (lower efficiency) capacity resources across futures

Portfolio Scoring Metrics

PGE's IRP seeks least cost, least risk portfolios. For each portfolio, PGE measures:

Cost – 50 %

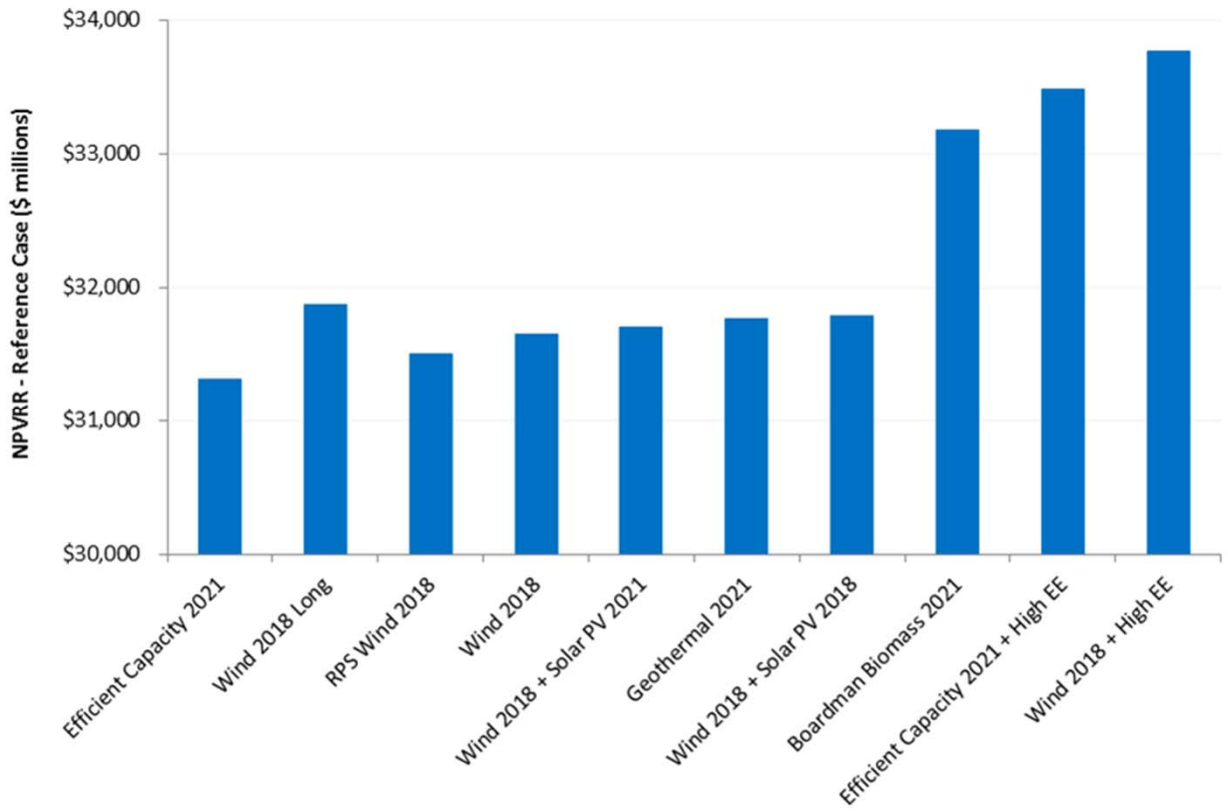
- Expected portfolio cost

Risk – 50%

- Severity – the magnitude of most expensive outcomes
- Variability – the distribution of expensive outcomes
- Risk Durability – the likelihood of avoiding expensive outcomes

Portfolio Scoring Metrics – Cost

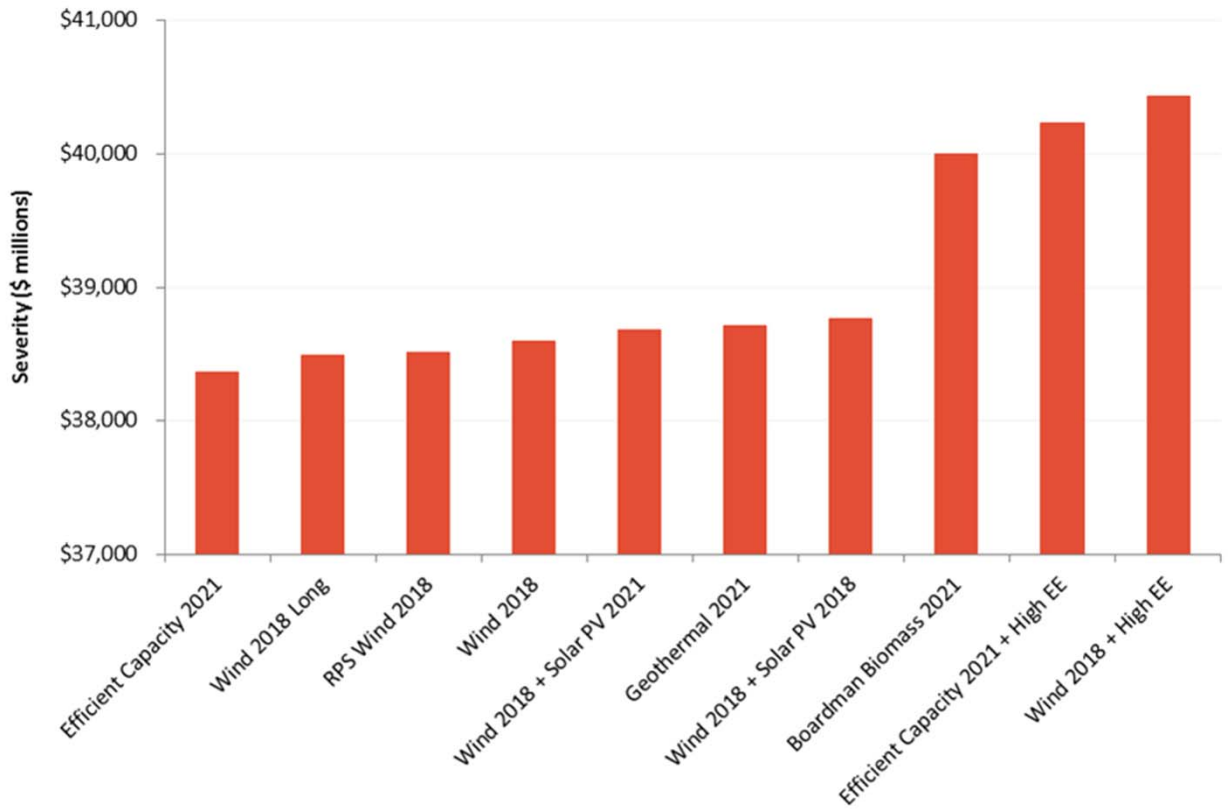
Cost			
	1. Net Present Value of Revenue Requirement (NPVRR)		
Weight	*50%*		
Risk			
	2. Severity	3. Variability	4. Durability Across Futures
Weight	*16.7%*	*16.7%*	*16.7%*



Portfolio	Value	Score
Efficient Capacity 2021	31,319	100
RPS Wind 2018	31,504	92
Wind 2018	31,652	86
Wind 2018 + Solar PV 2021	31,705	84
Geothermal 2021	31,769	82
Wind 2018 + Solar PV 2018	31,792	81
Wind 2018 Long	31,875	77
Boardman Biomass 2021	33,173	24
Efficient Capacity 2021 + High EE	33,476	12
Wind 2018 + High EE	33,768	0

Portfolio Scoring Metrics – Severity

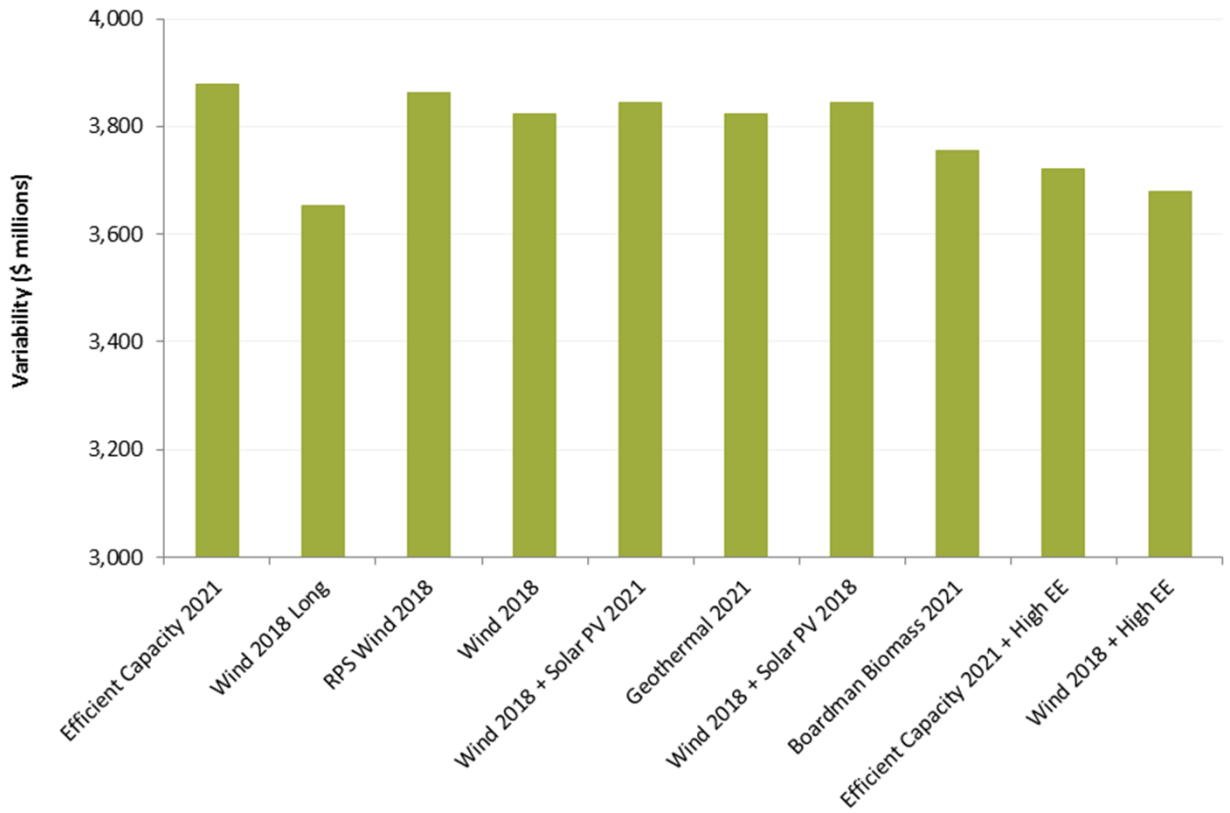
Cost			
	1. Net Present Value of Revenue Requirement (NPVRR)		
Weight	*50%*		
Risk			
	2. Severity	3. Variability	4. Durability Across Futures
Weight	*16.7%*	*16.7%*	*16.7%*



Portfolio	Value	Score
Efficient Capacity 2021	38,369	100
Wind 2018 Long	38,492	94
RPS Wind 2018	38,509	93
Wind 2018	38,593	89
Wind 2018 + Solar PV 2021	38,682	85
Geothermal 2021	38,711	83
Wind 2018 + Solar PV 2018	38,769	81
Boardman Biomass 2021	39,999	21
Efficient Capacity 2021 + High EE	40,228	10
Wind 2018 + High EE	40,431	0

Portfolio Scoring Metrics – Variability

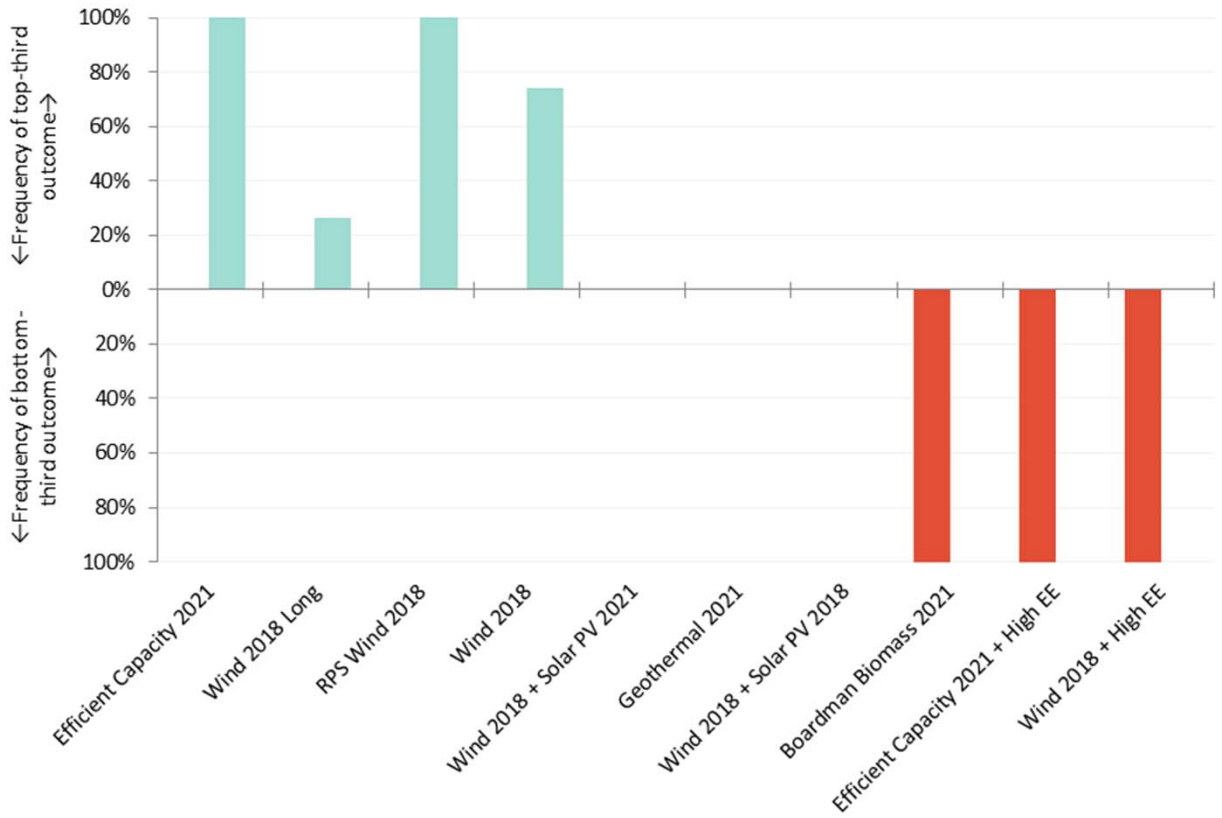
Cost			
	1. Net Present Value of Revenue Requirement (NPVRR)		
Weight	*50%*		
Risk			
	2. Severity	3. Variability	4. Durability Across Futures
Weight	*16.7%*	*16.7%*	*16.7%*



Portfolio	Value	Score
Wind 2018 Long	3,654	100
Wind 2018 + High EE	3,678	89
Efficient Capacity 2021 + High EE	3,720	70
Boardman Biomass 2021	3,756	54
Wind 2018	3,823	24
Geothermal 2021	3,824	24
Wind 2018 + Solar PV 2018	3,843	15
Wind 2018 + Solar PV 2021	3,843	15
RPS Wind 2018	3,861	7
Efficient Capacity 2021	3,877	0

Portfolio Scoring Metrics – Durability Across Futures

Cost			
	1. Net Present Value of Revenue Requirement (NPVRR)		
Weight	*50%*		
Risk			
	2. Severity	3. Variability	4. Durability Across Futures
Weight	*16.7%*	*16.7%*	*16.7%*



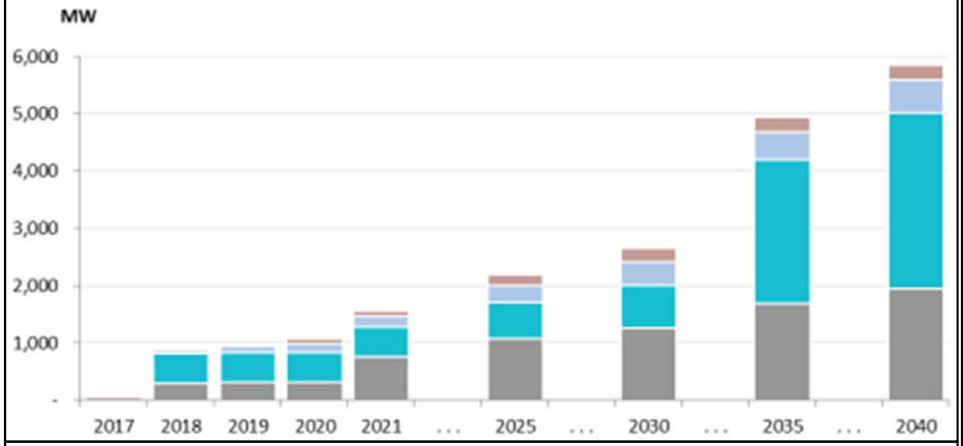
Portfolio	Value	Score
RPS Wind 2018	100%	100
Efficient Capacity 2021	100%	100
Wind 2018	74%	87
Wind 2018 Long	26%	63
Wind 2018 + Solar PV 2021	0%	50
Geothermal 2021	0%	50
Wind 2018 + Solar PV 2018	0%	50
Efficient Capacity 2021 + High EE	(100%)	0
Wind 2018 + High EE	(100%)	0
Boardman Biomass 2021	(100%)	0

Portfolio Scoring Metrics – Results

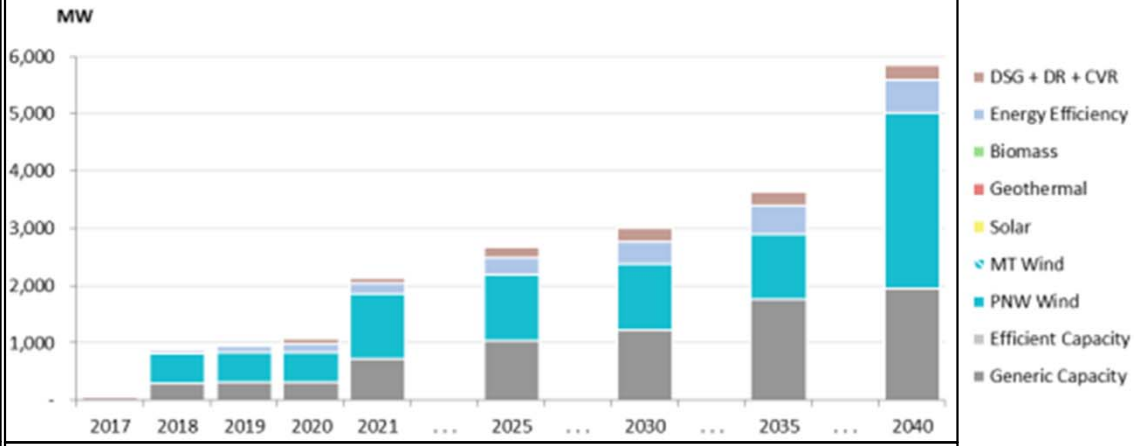
		Metric Weighting	50%	16.7%	16.7%	16.7%	= 100%
Draft Rank	Rank	Portfolio Name	Cost Score	Severity Score	Variability Score	Durability Score	Weighted Score
1	1	Efficient Capacity 2021	100	100	0	100	83
3	2	Wind 2018 Long	77	94	100	63	81
2	3	RPS Wind 2018	92	93	7	100	80
4	4	Wind 2018	86	89	24	87	77
5	5	Wind 2018 + Solar PV 2021	84	85	15	50	67
6	6	Geothermal 2021	82	83	24	50	67
7	7	Wind 2018 + Solar PV 2018	80	81	15	50	65
8	8	Boardman Biomass 2021	24	21	54	0	25
9	9	Efficient Capacity 2021 + High EE	12	10	70	0	19
10	10	Wind 2018 + High EE	0	0	89	0	15

Composition of Top Four Portfolios

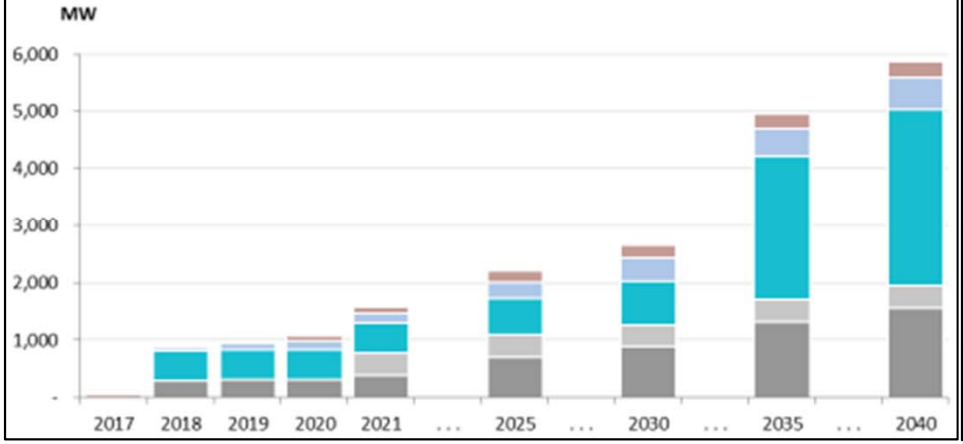
RPS 2018: 100% PTC wind (175 MWa), RPS compliance, resource adequacy with generic capacity



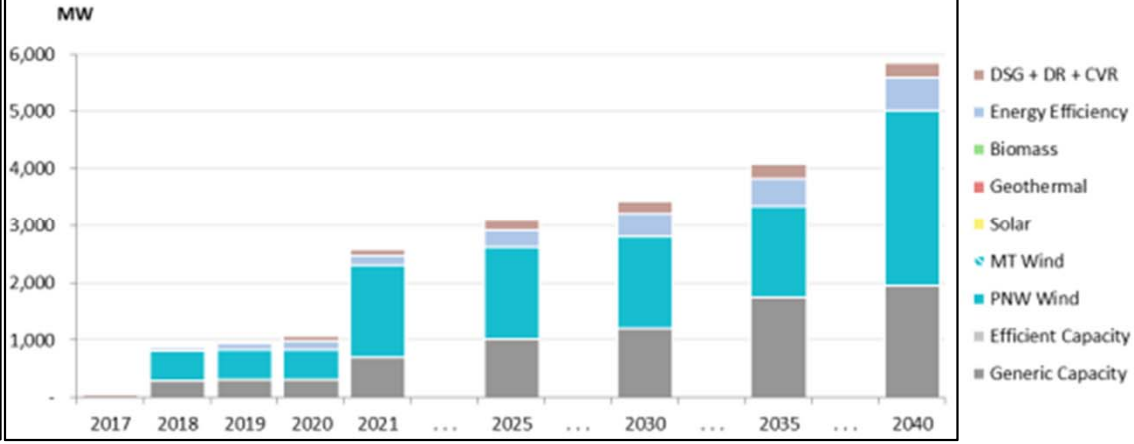
Wind 2018: 100% PTC wind (175 MWa) + 2021 wind (213 MWa), RPS compliance, resource adequacy with generic capacity



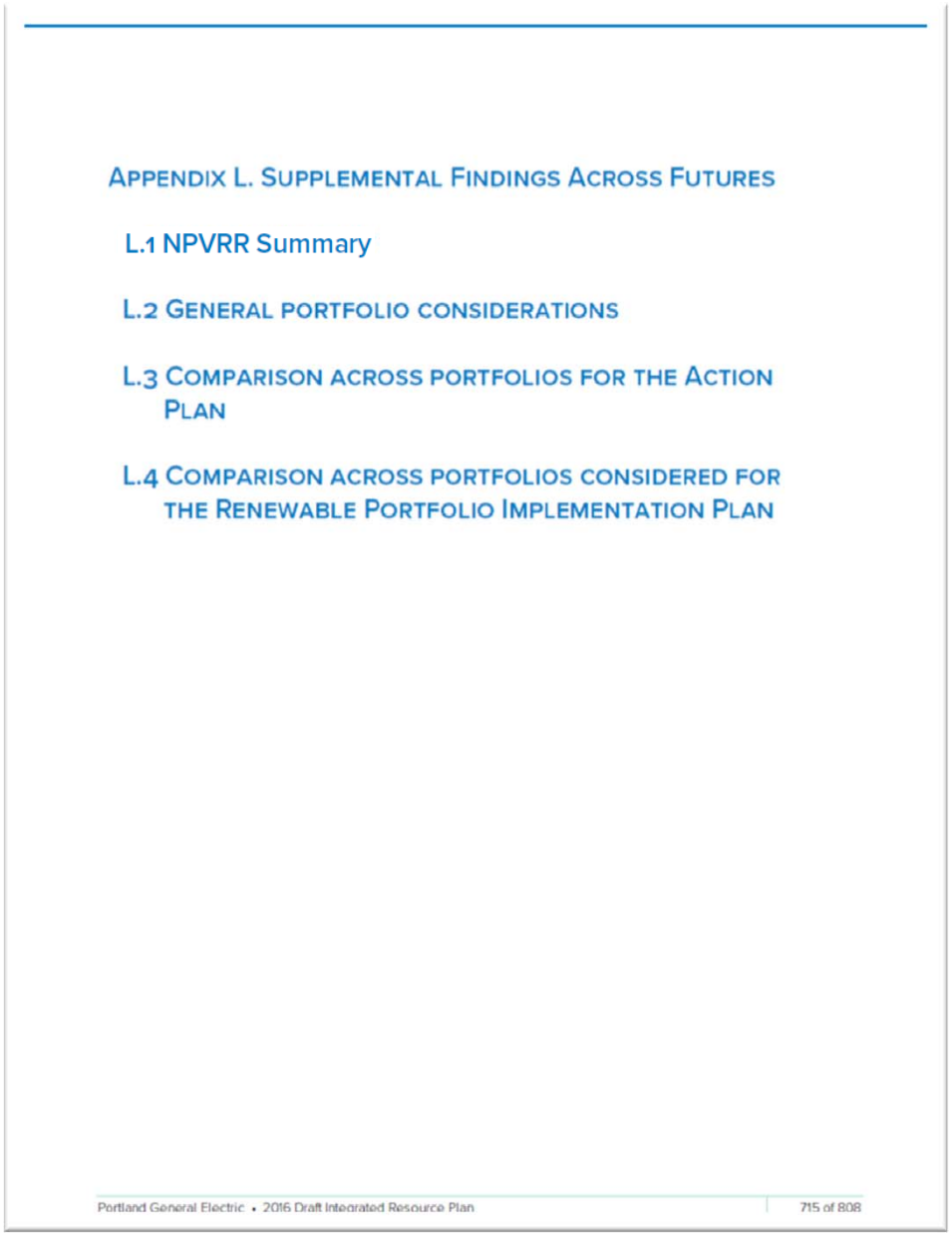
Efficient Capacity 2021: 100% PTC wind (175 MWa), RPS compliance, resource adequacy with generic and efficient capacity



Wind 2018 Long: 100% PTC wind (175 MWa) + 2021 wind (367 MWa), RPS compliance, resource adequacy with generic capacity



Exploring the IRP – Appendix L



APPENDIX L. SUPPLEMENTAL FINDINGS ACROSS FUTURES

L.1 NPVRR Summary

L.2 GENERAL PORTFOLIO CONSIDERATIONS

L.3 COMPARISON ACROSS PORTFOLIOS FOR THE ACTION PLAN

L.4 COMPARISON ACROSS PORTFOLIOS CONSIDERED FOR THE RENEWABLE PORTFOLIO IMPLEMENTATION PLAN

Portland General Electric • 2016 Draft Integrated Resource Plan 715 of 808

L1
- NPVRR summary

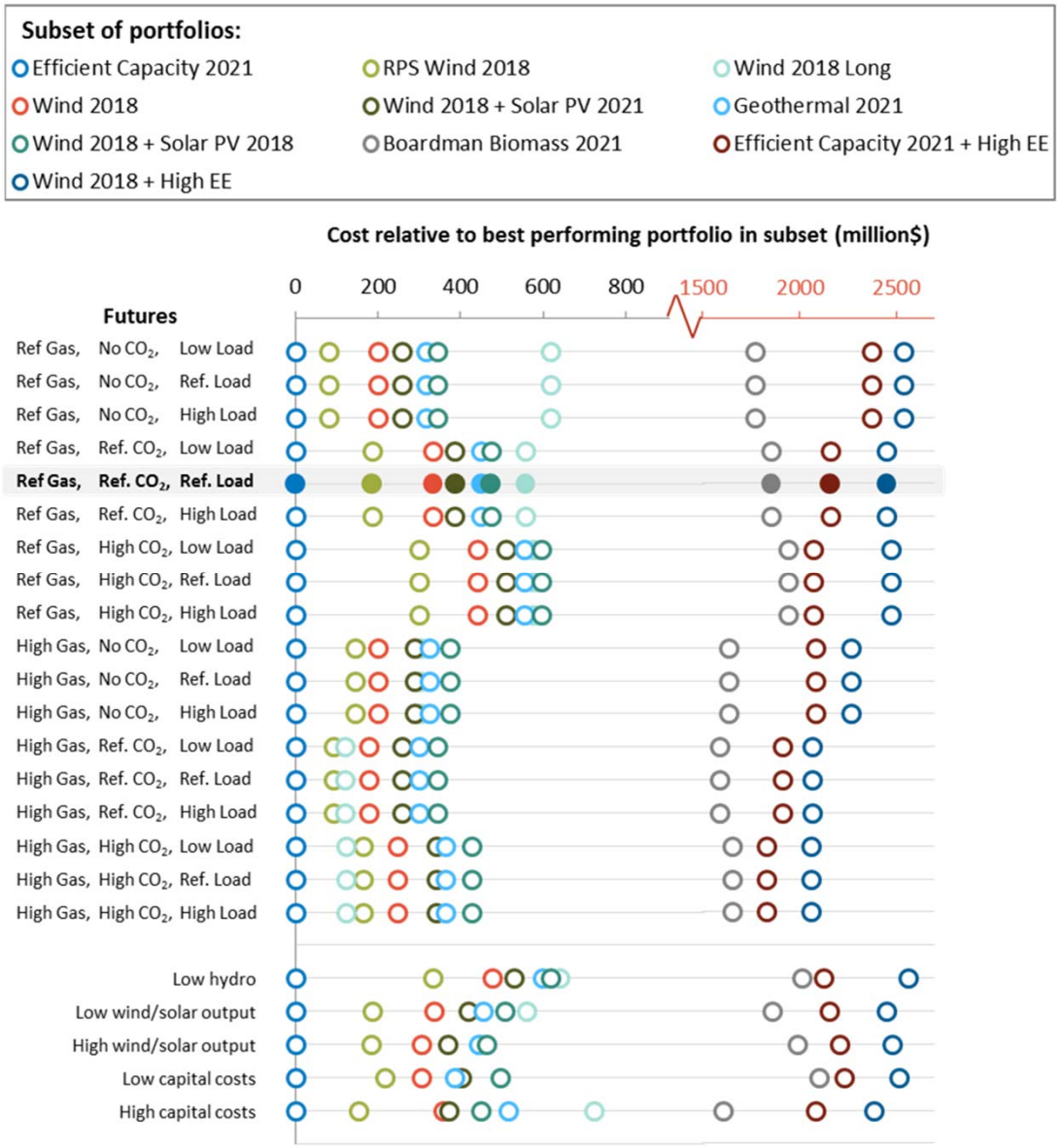
L2
- General Portfolio Conclusions

L3
- Comparison across portfolios considered for the Action Plan

L4
- Comparison across portfolios considered for the Renewable Portfolio Implementation Plan

Exploring the IRP – Appendix L

FIGURE 1-8: Relative NPVRR of portfolios considered for the Action Plan



Subset of portfolios

Cost relative to lowest cost portfolio within subset of portfolios

RFP Development

Jimmy Lindsay

PGE Goals

2016 IRP Action Plan

- Demand-Side Actions
  - 176 MW of Energy Efficiency
  - 69-77 MW of Demand Response
  - CVR deployment

- Supply-Side Actions
  - 175 MWa of renewable additions (equivalent to 515 MW of PNW wind)
  - 375-550 MW of dispatchable capacity
  - Up to 400 MW of annual capacity products

IRP schedule

- 11/15/2016 Final 2016 IRP to be filed
- 05/26/2017 OPUC Staff Memo
- 06/15/2017 OPUC Order Entered

Peak capacity deficit begins January 2021

- Long lead time for new resource development requires RFP approval process to begin in Q3 2017

Near Term Need for Independent Evaluator

RFP design to be developed in parallel with IRP acknowledgement process.

- PGE seeks an independent evaluator to facilitate RFP design
- Guideline 6 calls for IE participation in RFP development
  - "The utility will consult with the IE in preparing the RFPs…"
- PGE seeks to build IE familiarity with RFP analysis and IRP tools including:
  - Form contract development
  - Price scoring model
  - Non-price scoring rubric and methodology
  - Portfolio analysis
- PGE seeks to issue an IE RFP in order to onboard an IE capable of facilitating RFP design

Schedule of IE RFP Development

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Guideline 5:

- Commission Staff, with input from the utility and interested, non-bidding parties, will recommend an IE to the Commission, which will then select or approve an IE for the RFP.

IE RFP schedule:

Milestone	2011 IE RFP	2016/2017 Proposed IE RFP
IE RFP-Prework	December 2010	Early Nov
Coordination with OPUC Staff	January 2011	Mid Dec
IE RFP Issued	1/25/2011	Late Dec
RFP Responses Due	2/8/2011	Late Jan
IE RFP Docketed (UM 1524 in 2011)	2/18/2011	Mid Feb
Company files application	2/18/2011	Mid Feb
Staff Report	3/28/2011	Mid March
Order Approving IE Selection	4/11/2011	Late March

IE Applicant Pool

Independent evaluators to be invited to participate in IE RFP include, but are not limited to:

Candidate Independent Evaluators	
E3	Thorndike Landing
EnerVision, Inc	Vantage Consulting
Global Energy Concepts	Accion Group, LLC.
ICF International	Boston Pacific Company, Inc.
KEMA Inc.	Concentric Energy Advisors, Inc.
Knight Piesold & Co.	Levitan & Associates, Inc.
Lands Energy Consulting	London Economics International, LLC
Merrimack Energy	NERA Economic Consulting
Navigant	PA Consulting Group
The Brattle Group	ABB

Additional candidate IE recommendations provided by December 16th are welcome.

IE RFP Scope Summary and Next Steps

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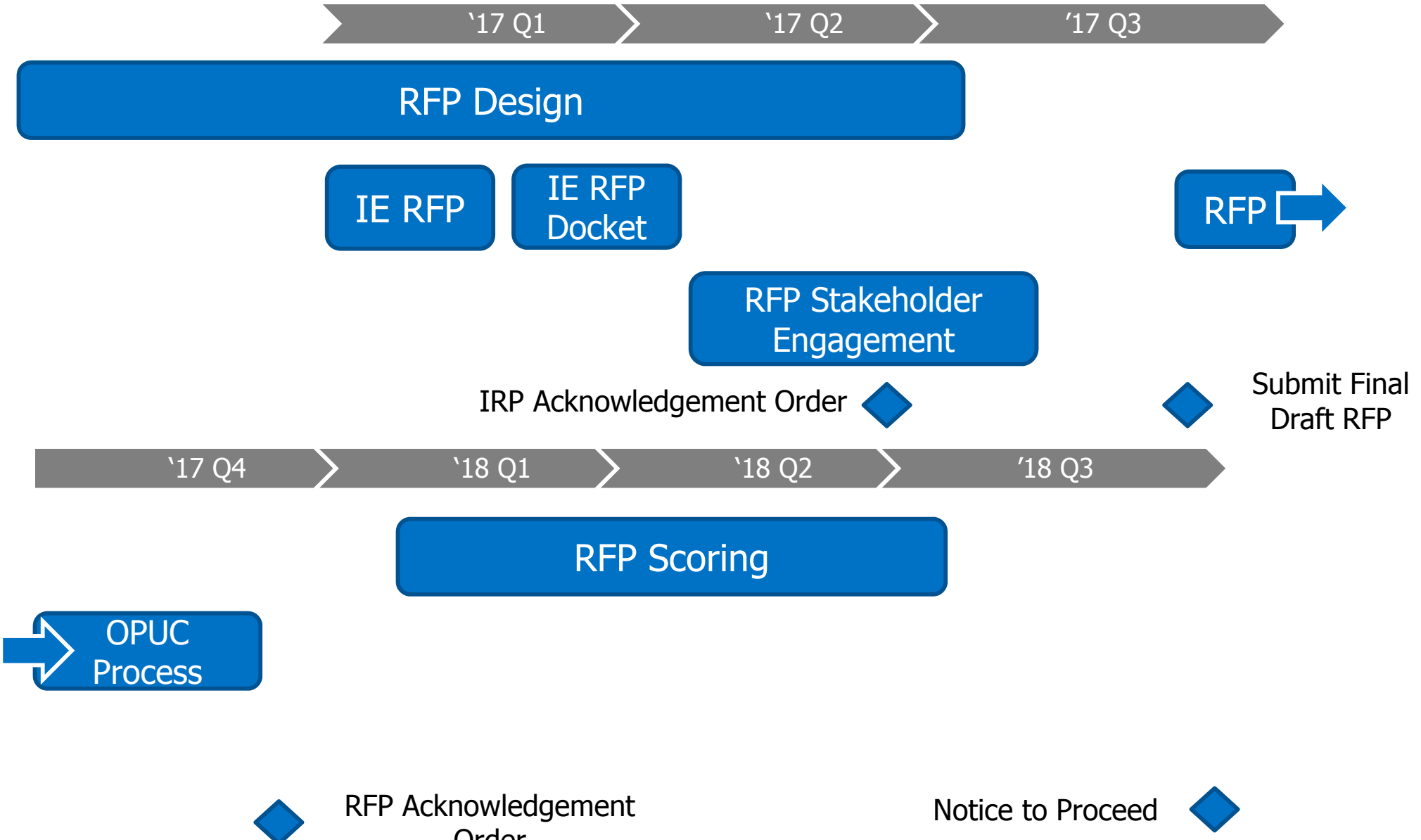
Important elements of proposed IE RFP

- Technical capability
- Experience with regulatory process
- Experience in previous utility independent evaluator / monitor roles
- Electronic bidding platform
- Reasonable price

PGE proposes to issue IE RFP year end 2016

Proposed application for IE selection to OPUC end of Q1 2017

RFP Schedule



Market Discussion

Kate von Reis Baron

Market discussion

- **Capacity and Energy**
- **Energy Position**
  - Previous IRPs focused primarily on meeting energy need
  - In PGE's 2016 IRP, the energy position is treated as a risk assessed through scenario analysis, not as a resource need
- **Capacity and Reliability**
  - The region is transitioning to being energy long and capacity short with growing wind and solar resources and retiring coal and older natural gas resources
  - PGE's 2016 IRP is focused primarily on meeting future RPS requirements and capacity needs

2016 IRP portfolios contain open energy and capacity positions. The action plan includes the opportunity to fill a portion of the remaining capacity need with market capacity.

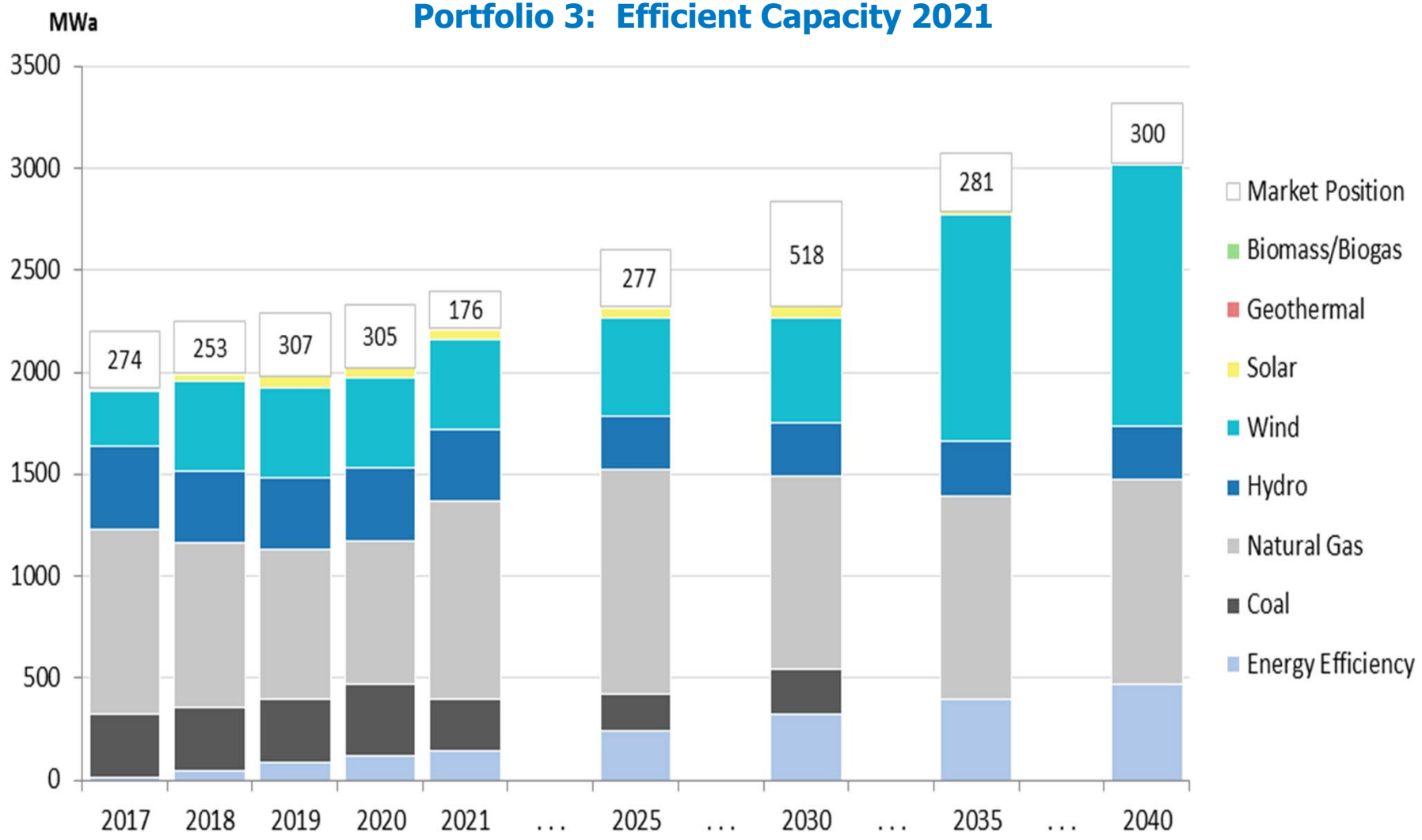
PGE Capacity and Energy

Reliability Requirements		Economic Dispatch
RECAP reliability model, PGE system	**RECAP modeling determines capacity needed to meet reliability obligations**	AURORA model, WECC dispatch
30+ years of hourly load/weather data, capturing peak excursions		Average load/weather
Limited spot market access		Unconstrained access to spot market
Detailed capacity contribution modeling (forced outage, shaft-risk, variability, correlation with load, etc.)	**Energy position determined by economic dispatch**	PGE resources dispatch to market price
Determines capacity needed to meet reliability obligations		Allows PGE to reduce variable costs through economic market purchases and sales

IRP Energy Position

With few exceptions, all portfolios maintain a net open position to the energy market

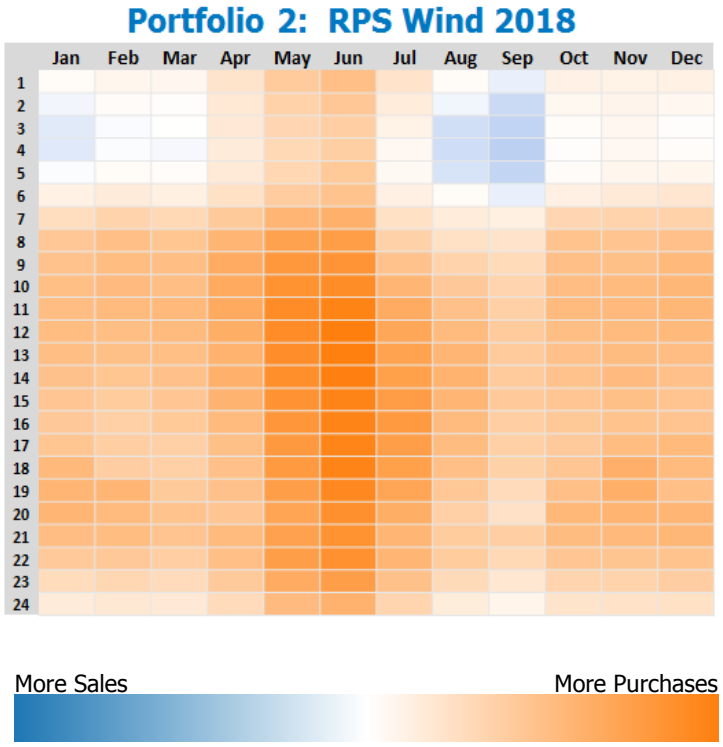
Portfolio 3: Efficient Capacity 2021



IRP Energy Position – Year 2025

PGE reduces power costs with economic energy purchases and sales. Net market purchases vary across season and time of day.

- Portfolio 2 meets remaining capacity need (after EE, DR, RPS, DSG) with Generic Capacity (low fixed costs, higher variable costs). PGE's 2025 net market position shows purchases across the On-peak hours.
- Portfolio 3 replaces a portion of Generic Capacity with Efficient Capacity (higher fixed costs, lower variable costs). While the exposure to summer and winter On-peak prices is reduced, PGE remains a net market purchaser across the On-peak hours.



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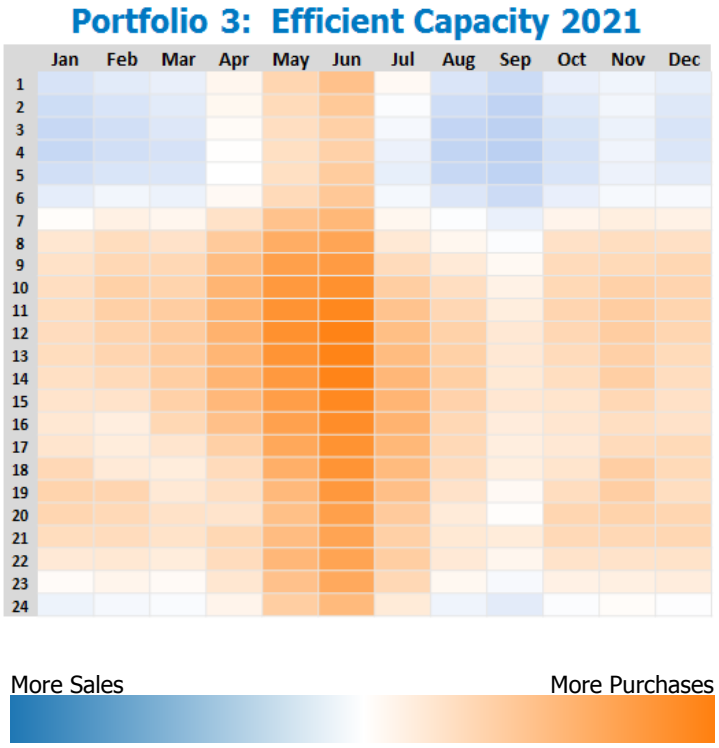
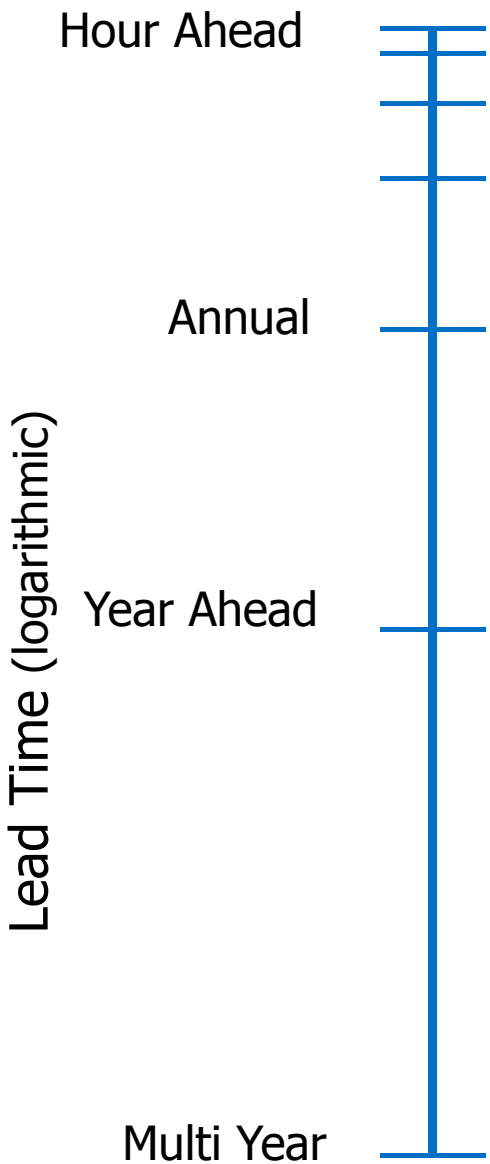


Capacity Types in the IRP



- Constrained Spot Market Purchases -> RECAP

- Short-Term Purchases -> Generic Capacity
  e.g., 'Front Office Transactions', call options, block purchases backed by physical resources

- Mid-Term Purchases -> Generic Capacity
  e.g., 'Bridging Contracts', seasonal products, tolling agreements backed by physical resources

- Competitive Procurement for Resource Additions -> Portfolio Analysis

Market Capacity

Market Capacity

- PGE considers "market" capacity to be short and mid-term capacity contracts for existing resources executed through bilateral negotiations or an RFP process
- A portion of PGE's capacity need may be particularly suited to market capacity products
- PGE's action plan provides the opportunity to utilize market capacity if available at competitive prices

Capacity Open Position

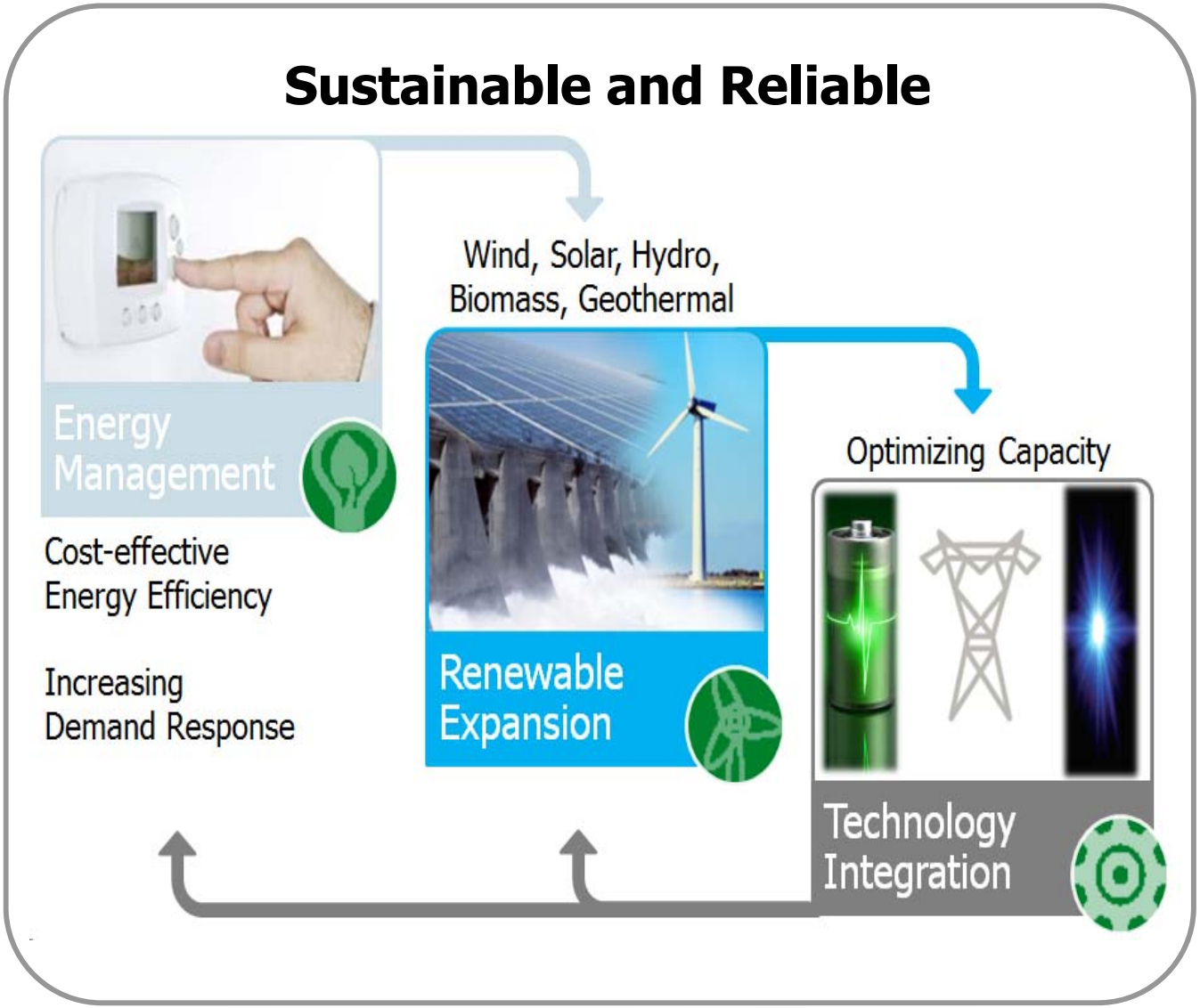
(unsecured capacity)

- In addition to the market capacity opportunities in PGE's action plan, the IRP capacity needs assessment includes an assumption of 200 MW spot market availability outside of summer peak hours (a capacity open position)
- PGE also maintains an open position with respect to obligations for long-term opt-out load (almost 200 MW), which per Guideline 9, are excluded from IRP planning

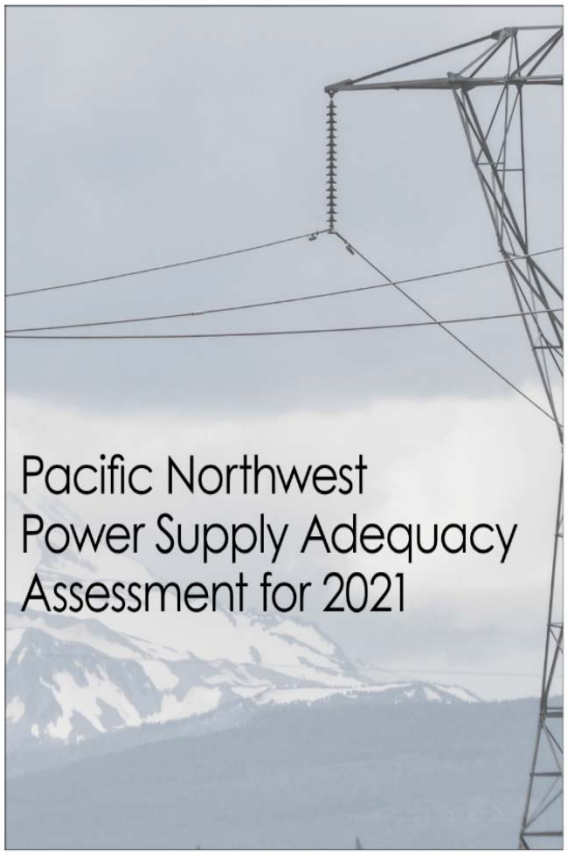
Meeting Capacity Needs

Resources that can contribute to meeting capacity need include:

- Additional EE and DR
- RPS resources
- Hydro resources
- Energy storage
- Natural gas resources
- Contracts
  - Seasonal capacity
  - Block purchases
  - Tolling agreements



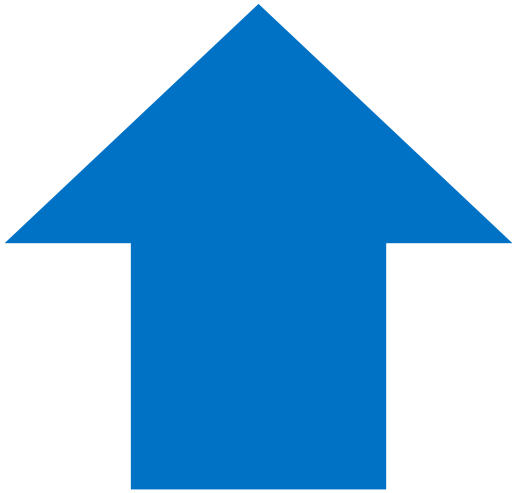
Regional reliability and supply adequacy



Study Year	Analysis Vintage	LOLP	Capacity (MW) needed to meet 5% LOLP	Observations
2021	2015	8.3%	(unstated)	Early estimate (BPA INC/DEC only) Loss of Boardman and Centralia 1 (~1,330 MW)
2021	2016	10%	1,040 MW	2021 loads lower than last year's forecast (~1,500 aMW) but winter peaks are higher (~3,000 MW), using regional INC/DEC reduces hydro peaking by as much as 2,000 MW
2021	**2016**	**13.2%**	**1,360 MW**	**Accounts for Colstrip units 1 & 2 retirement**

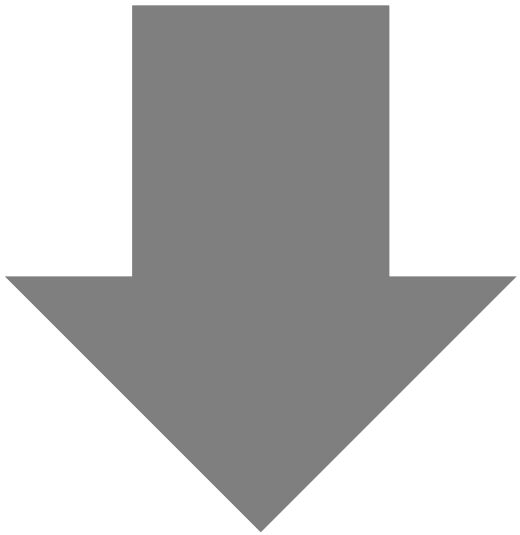
Assumes EE targets achieved.

Regional Capacity



If region has several uncommitted physical resources with firm delivery options to PGE, PGE may receive:

- Multiple bids for mid-term and seasonal capacity products
- Competitive bid pricing



If region has a small number of uncommitted physical resources with firm delivery options to PGE, PGE may receive:

- Few bids for mid-term and seasonal capacity products
- High bid pricing

Technology Discussion

Rick Tetzloff

Technology Discussion

Portland General Electric

Main topics

- Bolstering renewables with flexibility
- Evolution of technology
- Emission profiles

Key learnings

- How generating facilities (of all types) are economically dispatched
- How substantial renewable expansion has fundamentally changed how electrical systems are operated and drives the need for flexibility
- How technologies have recently evolved to provide significantly more flexibility than ever before

Western US Generation Mix is Changing

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PG&E to close Diablo Canyon, California's last nuclear power plant

Los Angeles Times

APS plans to close one of the four generators at Cholla Power Plant

azcentral

PGE's coal-fired Boardman plant gets approval to close in 2020

The Oregonian

Agreement reached to stop burning coal at Centralia power plant

The Seattle Times

Colstrip coal plant in Montana agrees to close 2 units

The Olympian

North Valmy coal plant proposed to close by 2025

Idaho Statesman

Changing Generation Mix

- **WECC capacity …**
  15+ GW offline by 2025;
  coal, gas & nuclear
- **WECC generation …**
  56,000+ GWh need to be replaced based on 2015 generation
- **Shifting US resource mix …**
  - **Retirements:** coal (92 GW)
    oil/gas steam turbines (35 GW)
    old gas turbines (29 GW)
  - **Additions:** wind (69 GW)
    solar (100 GW)
    gas (93 GW)

Oregon passes 50% renewables standard into law

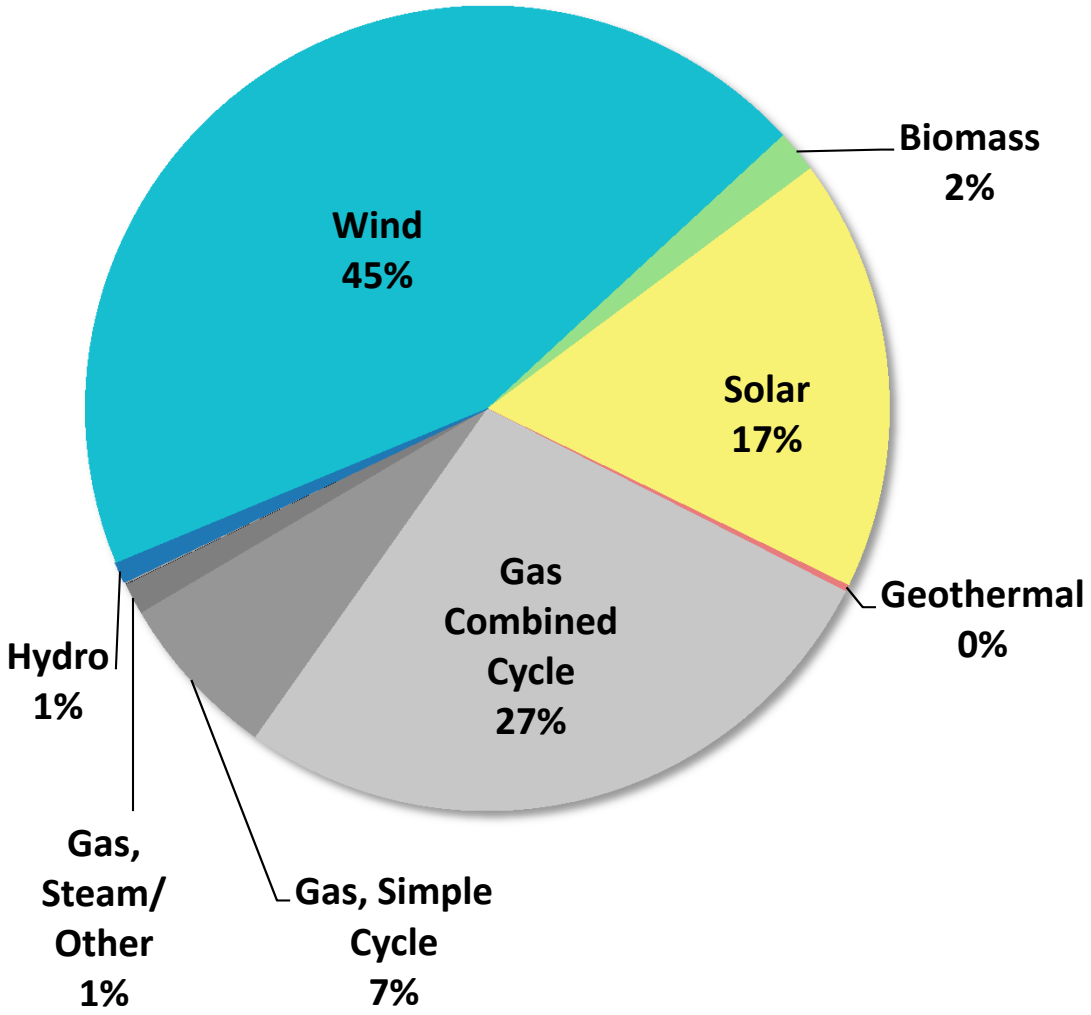
Utility DIVE

Source: ABB/Ventyx, EIA

2015 New Capacity Additions in US

The US is rapidly adding renewables

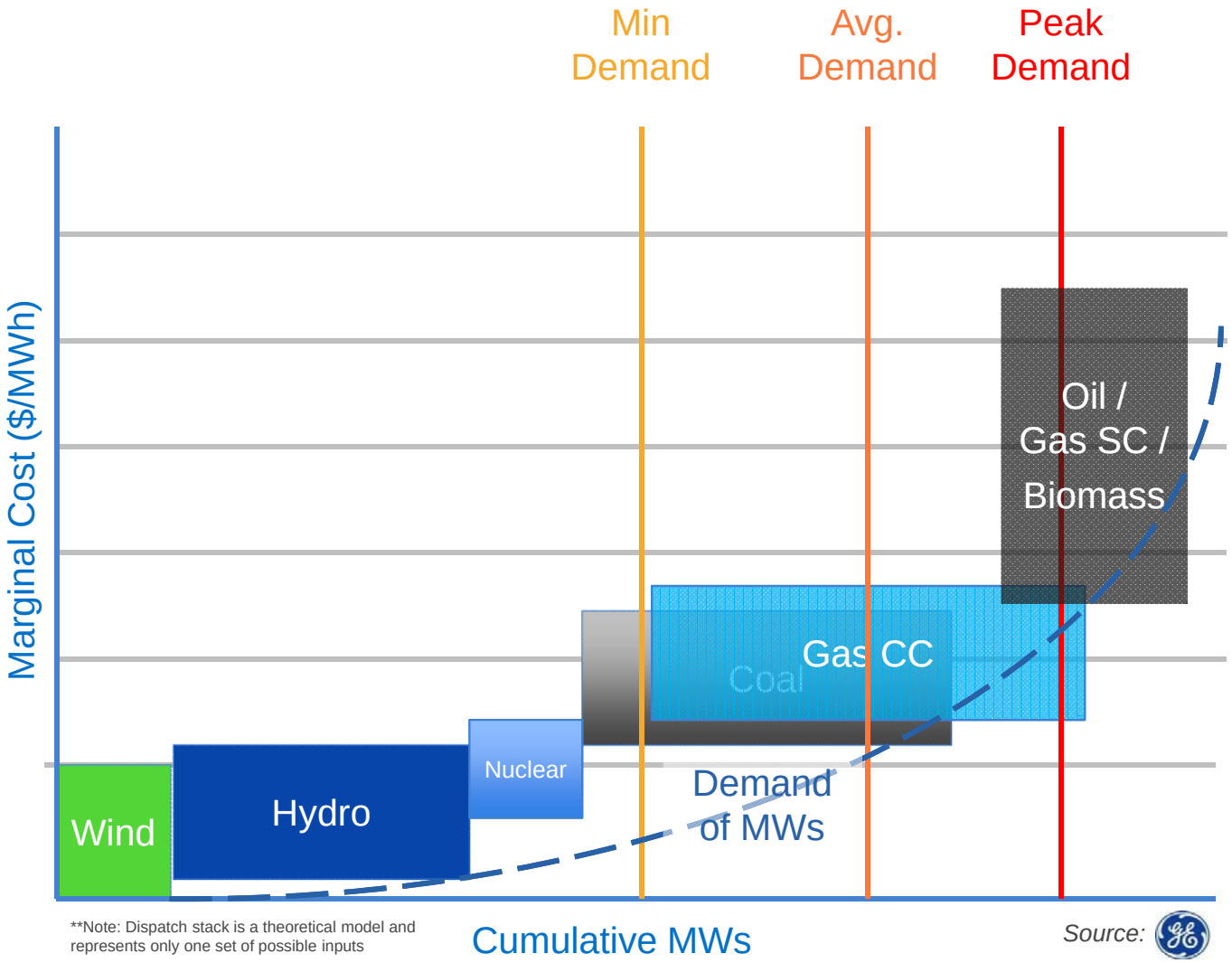
Total Capacity Installed in 2015:
18,400 MWs



new flexible generation is also being added to accelerate this transition

Dispatch Dynamics

Northwest Power Pool – Today



Low variable cost units first to dispatch

Variable nature of renewables resources requires flexible on-demand generation to integrate

Coal and gas compete based on fuel prices

Smaller, higher variable cost technology needed for less than 500 hours a year of peak demand

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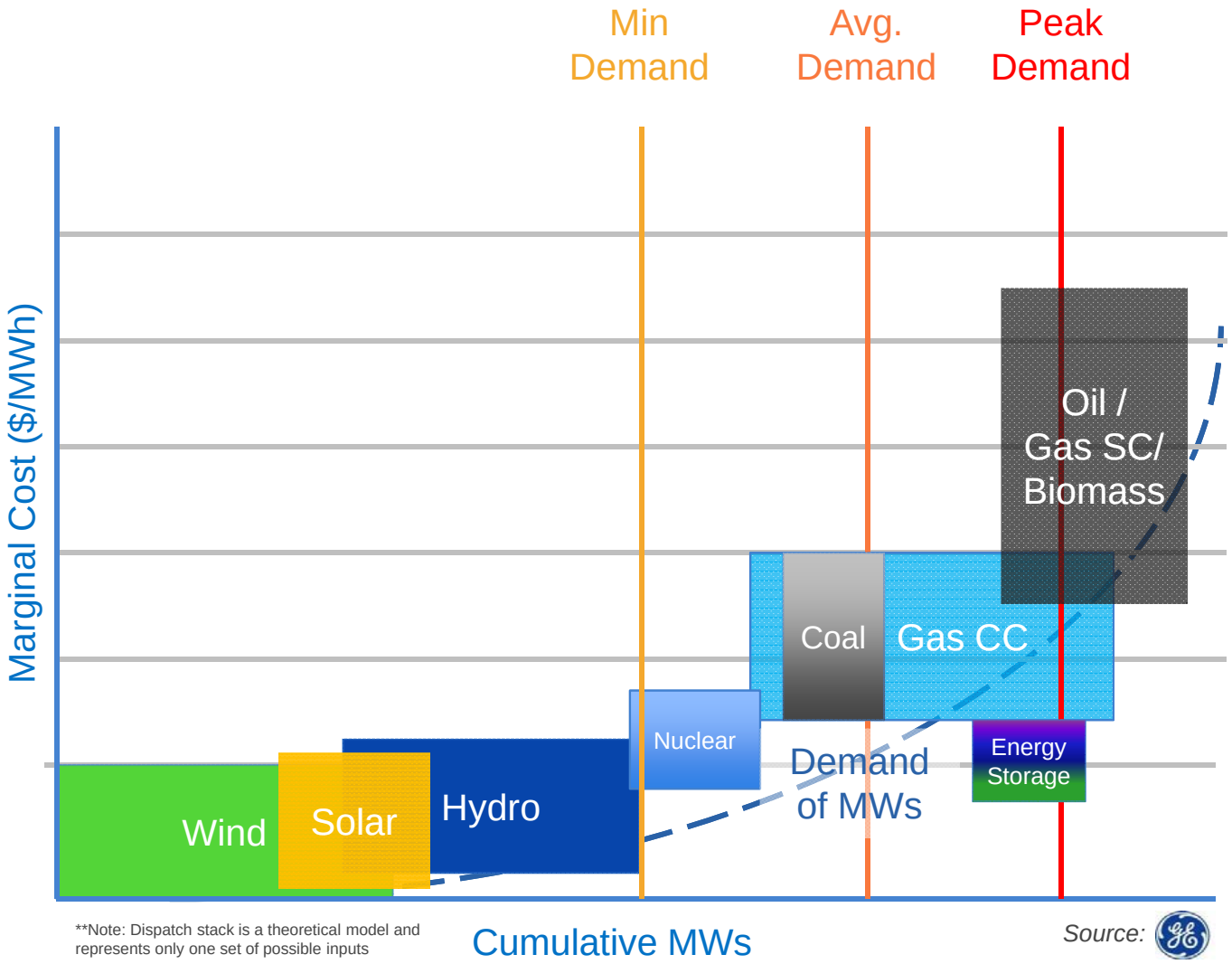
Northwest Power Pool – Future



Coal retirements

T&D infrastructure may be needed for greater variable resource integration

Flexibility needed to integrate supply from variable resources

Energy storage for energy arbitrage and ancillary services

Dispatch Dynamics for Two Different Days

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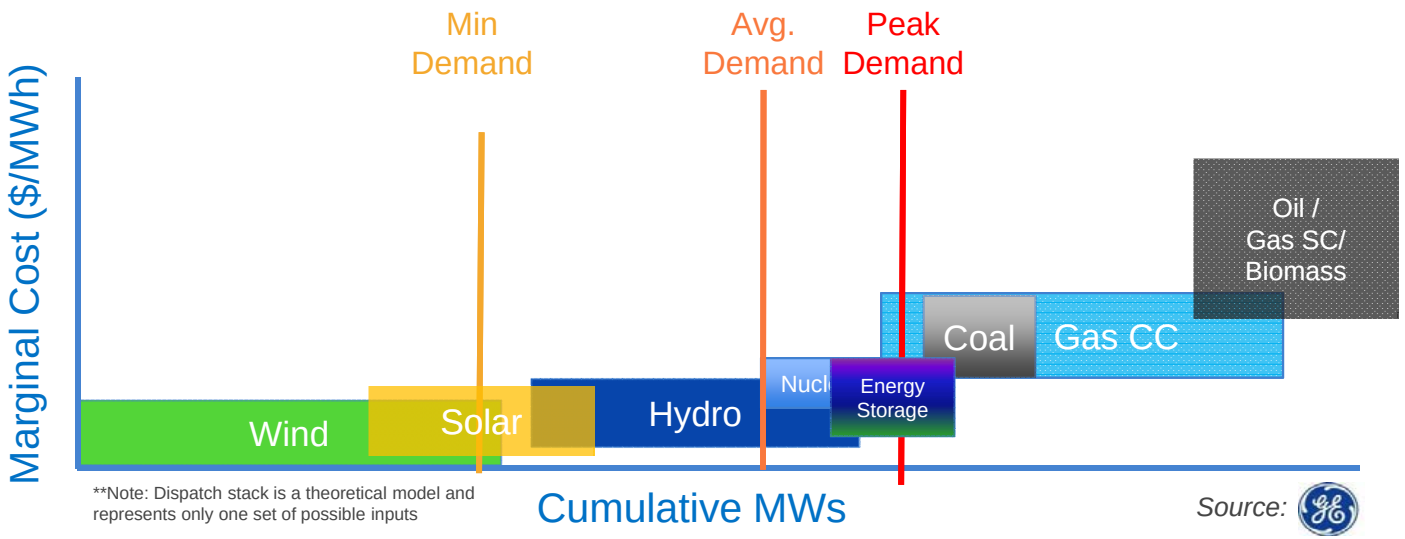
High Renewables Capacity Factor; Low Demand Day

Temperate Spring Day

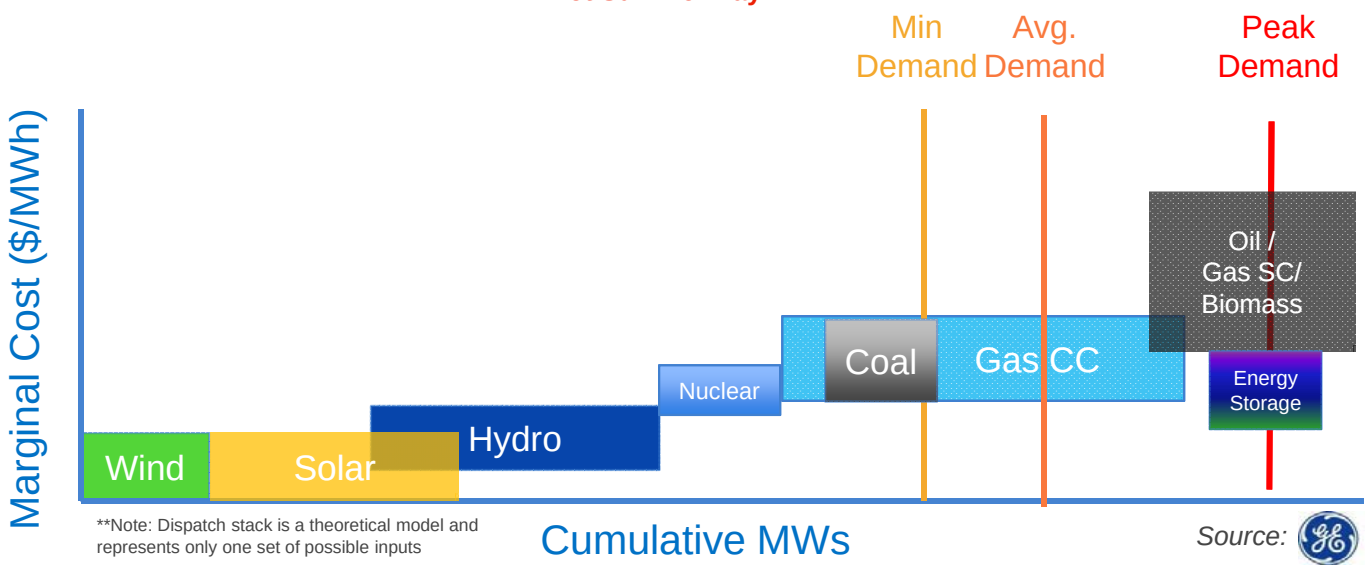


**Note: Dispatch stack is a theoretical model and represents only one set of possible inputs

Source:

Low Renewables Capacity Factor; High Demand Day

Hot Summer Day



**Note: Dispatch stack is a theoretical model and represents only one set of possible inputs

Source:

Historic 2013-15 US Capacity Factors by Unit Type – (EIA)

Nuclear	90-92%
Coal	55-61%
Gas CCGT	48-56%
Hydro	36-39%
Wind	32-34%
Solar PV	26-29%
Gas SCGT	5-7%

* Regional and Technology Variations

System designed for all supply and demand scenarios

Grids can handle more Renewables

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Flexibility and forecasting improvements are needed

Enablers of renewables

- Demand response
- Renewable forecasting
- Flexible fleet
- Faster quick starts
- Deeper turn-down
- Faster ramps
- Energy storage and electric vehicles

Challenges for integration

- Lack of transmission
- Lack of control area cooperation
- Unobservable and uncontrollable distributed generation
- Inflexible operating strategies during light load
- Inflexible markets

All grids can accommodate substantial amounts of renewables … need operational flexibility, policy and market structure

Source: GE Energy Consulting Group

Evolution of Gas Turbine Flexibility (GE)

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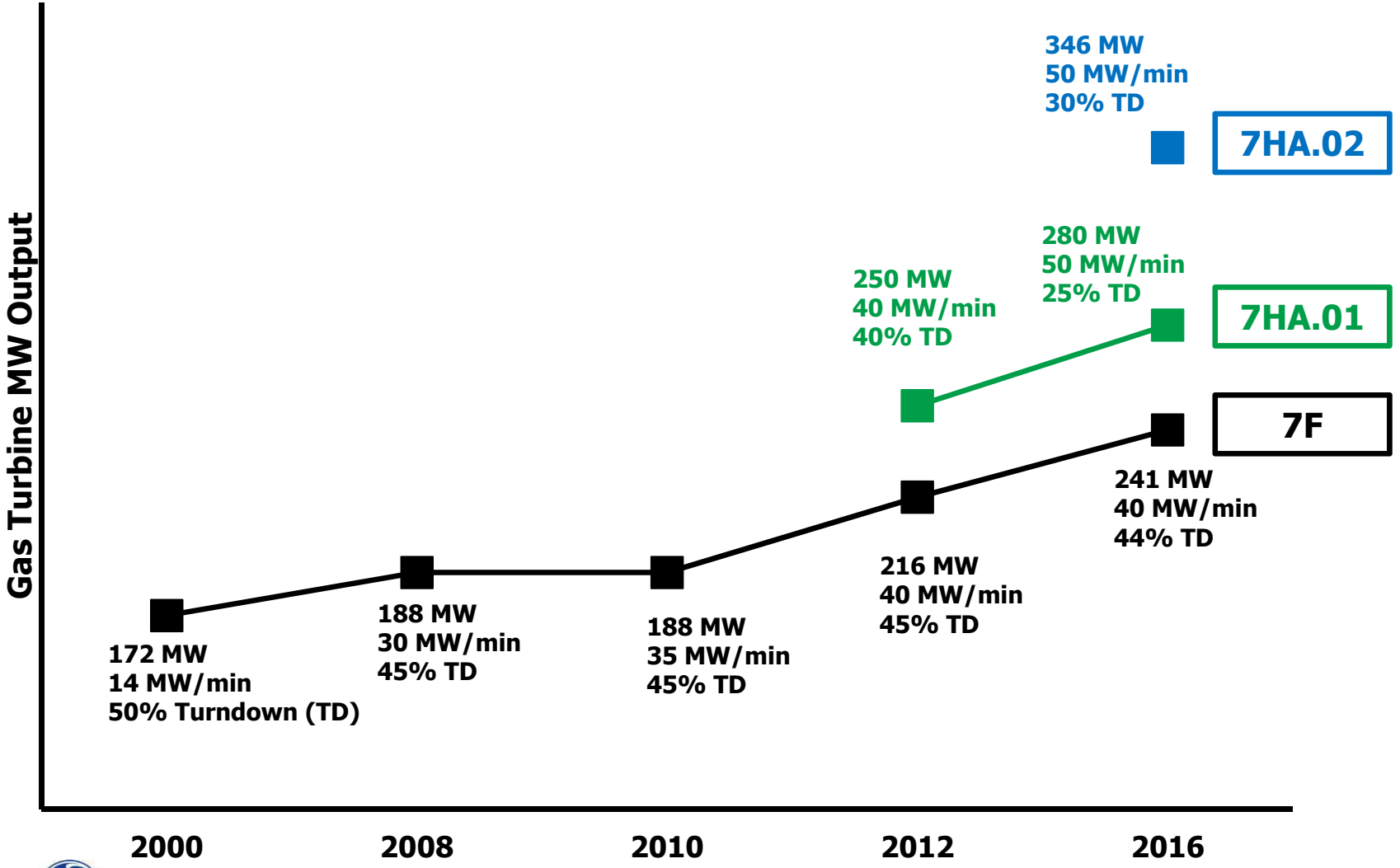
Flexibility driven by physical and digital improvements



imagination at work

*Gas turbine performance at time of product release

Flexibility Characteristics

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Next generation plants have increased flexibility

	Conventional Combined Cycle	Highly Flexible Recips 12 units	Highly Flexible Combined Cycle F/G/H/J Class	Highly Flexible Simple Cycle Frame CTG F/G/H/J Class
Cold Startup Times (to full load)	5-9 hr	<10 min	2.75 – 3.5 hr	10-21 min
Hot Startup Times	2-4 hr	<10 min	35-60 min	10-21 min
MW in 10 minutes	0	225	27-280	27-280
Ramp Rates, (MW/min)	10-20	5.3 each 64 total	40-50	40-50
Minimum Load	50%	30-40% each unit, ~3% overall	20-42%	25-42%
Heat Rates, Btu/kWh (HHV)	6,500-7,400	8,437	6,369-6,600	9,243-10,027
CO_2 Emissions, Full Load, (ton/MWh)	0.37-0.43	0.49	0.37-0.38	0.53-0.58

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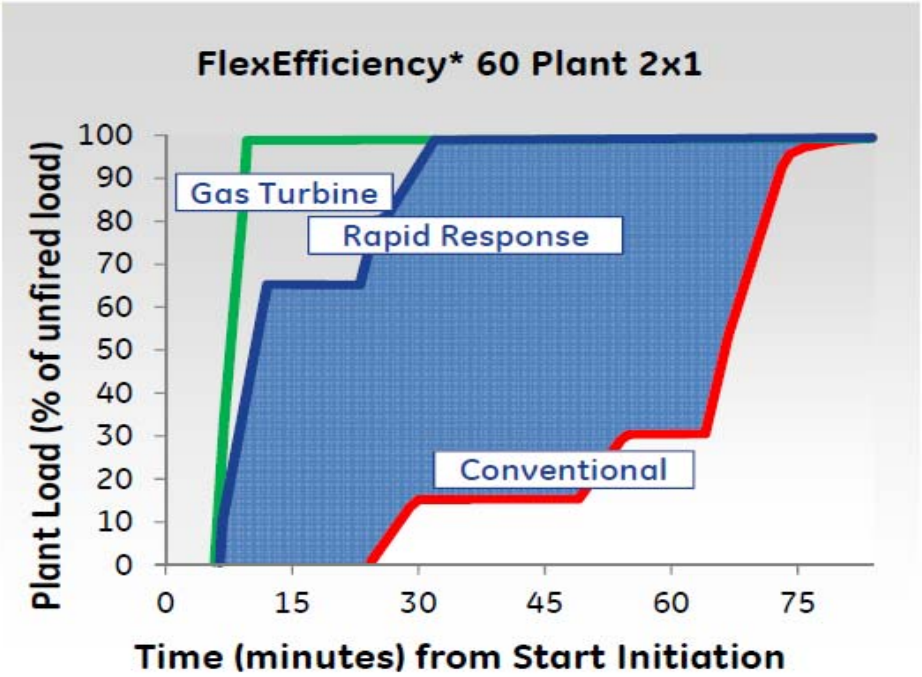
All technology providers are focused on flexibility

Rapid Response Startup

Benefits with Rapid Response

- Full load <30 minutes[1]
- Sync to grid <6 minutes
- Reduced start-up emissions and fuel consumption
- More capacity available for peak electricity demands
- Ancillary service opportunities
- Automated for predictability

[1]For hot starts with simultaneous start of both gas turbines.



7HA.01 Plant ... 1/2 a gigawatt in 10 minutes

imagination at work

* Trademark of General Electric Company

Mitsubishi M501JAC Fast Gas Turbine

Portland General Electric

Mitsubishi Fast-Start Concept

- 10-minute Fast Start capability
- Highest Efficiency in GT or CC Fast series
- Largest Capacity in GT or CC Fast series

Quick Start and Flexible Operation

- Faster MW on/off the grid
- Lower Start Up Emissions
- Renewables support

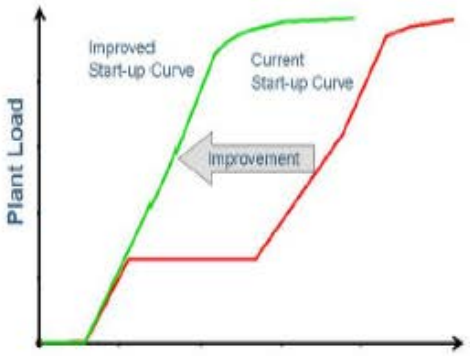
Siemens Co-start™ Combined Cycle Technology

Portland General Electric

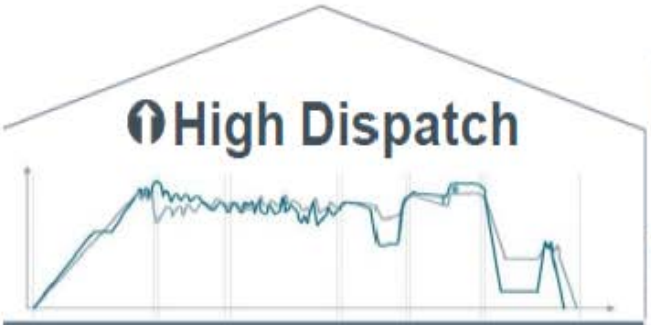
Low Cost of Generation

High Efficiency
Low GHG Production

High Flexibility



The performance of a Combined Cycle
The speed and flexibility of a simple cycle



Combined Cycles offer a lower levelized cost of electricity resulting in higher dispatch

Higher efficiency results in lower CO_2 production

High flexibility enables integration of fluctuating renewable resources

Siemens Flex-Plants

Portland General Electric

Bloomberg

Siemens Powers El Segundo Energy Center with Second Flex-Plant in the U.S.A.

"Flex-Plants with fast start technology are an environmentally friendly solution to seamlessly integrating renewable power into the grid. As a result of this project, the El Segundo Energy Center will be able to provide Californians with 550 MW of clean energy for decades to come"

John Chillemi, President of NRG Energy's West Region

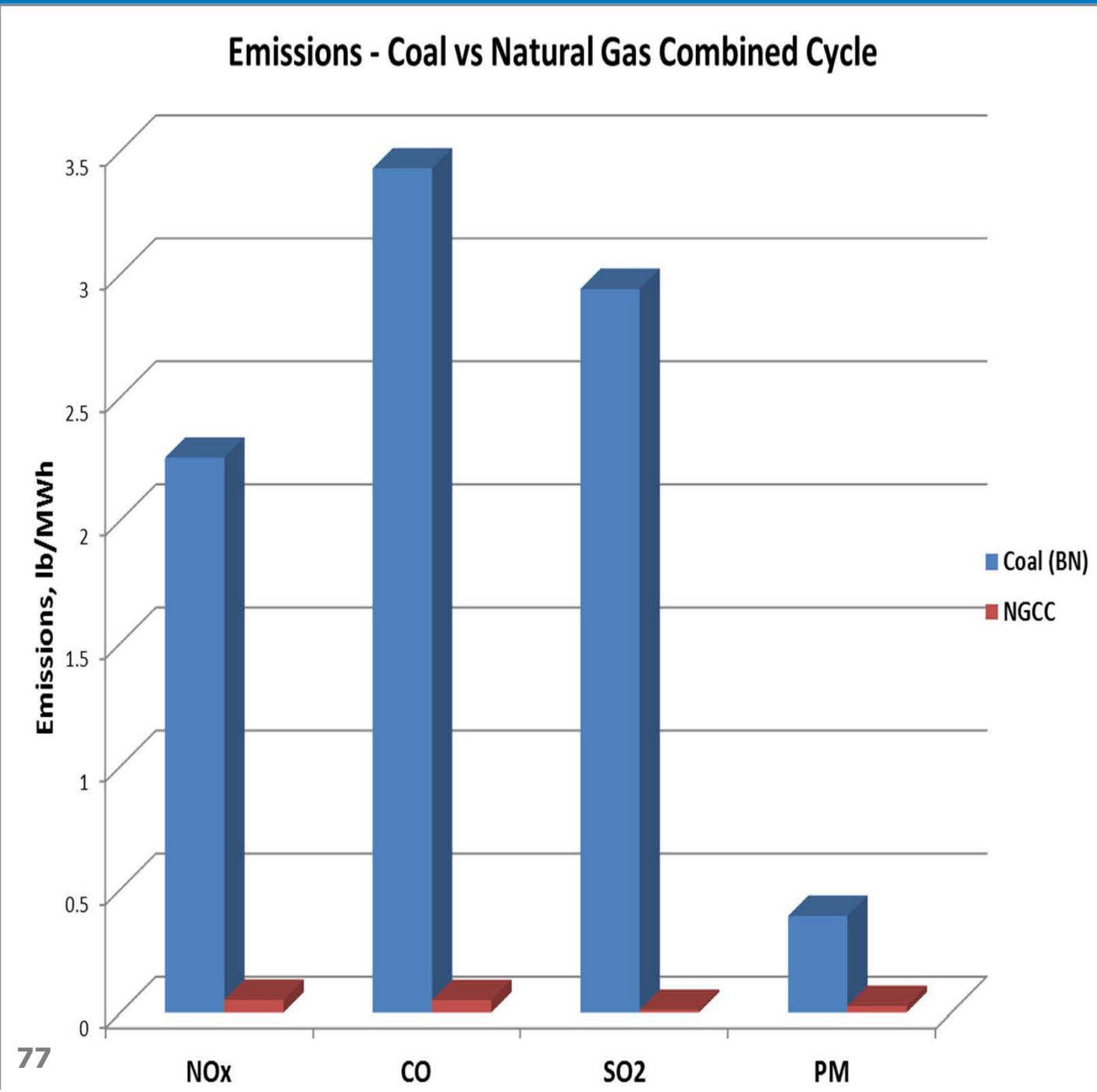
""We can't do what we want to do with solar and wind without having plants like this, with quick start and the ability to 'turn on a dime' in terms of output.""

Michael Peevey, President of the California Public Utilities Commission

Modern Power Systems
COMMUNICATING POWER TECHNOLOGY WORLDWIDE

Siemens Flex-Plant – The Efficiency and small environmental footprint of a combined cycle with the flexibility of a simple cycle

Emissions - Coal vs Natural Gas



Additional Information

White Papers

- Black & Veatch –2014 STRATEGIC DIRECTIONS: U.S. ELECTRIC INDUSTRY POWER GENERATION: NATURAL GAS AND RENEWABLES ARE A PERFECT PAIR
- NBER: Bridging the Gap: Do Fast Reacting Fossil Technologies Facilitate Renewable Energy Diffusion?
- JISEA: Pathways to Decarbonization: Natural Gas and Renewable Energy

Articles

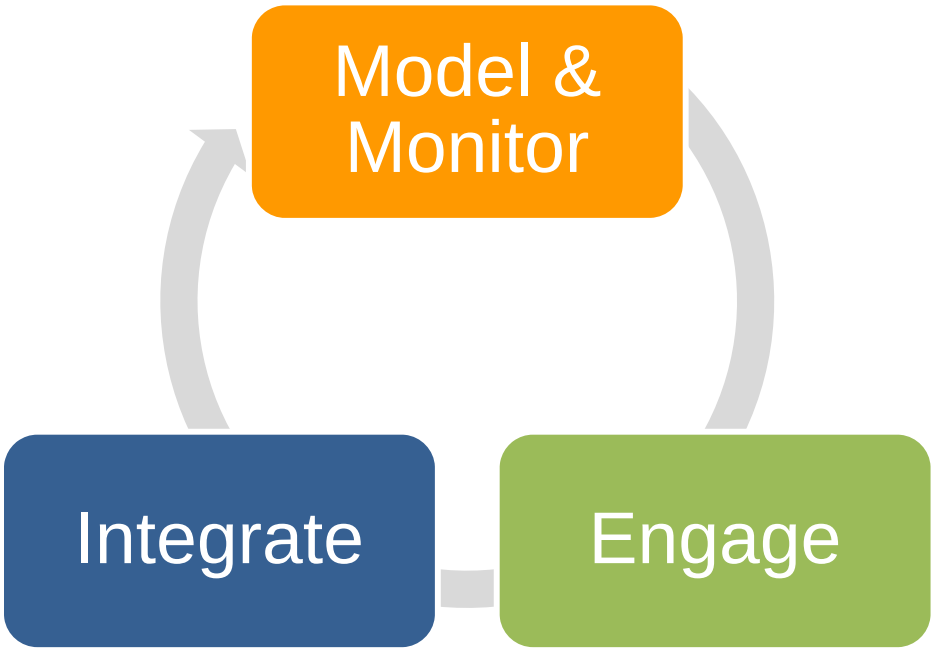
- Washington Post -Turns out wind and solar have a secret friend: Natural gas
- Cleantechnica - Natural Gas & Renewables Can Provide 100% Of Texas Electricity
- SparkLibrary - The Case for Natural Gas and Renewable Energy

Smart Grid Report

Brian Spak

Our Strategic Approach

PGE will advance the intelligent and integrated operation of our grid by leveraging technologies that deliver customer value and system benefits in a changing landscape

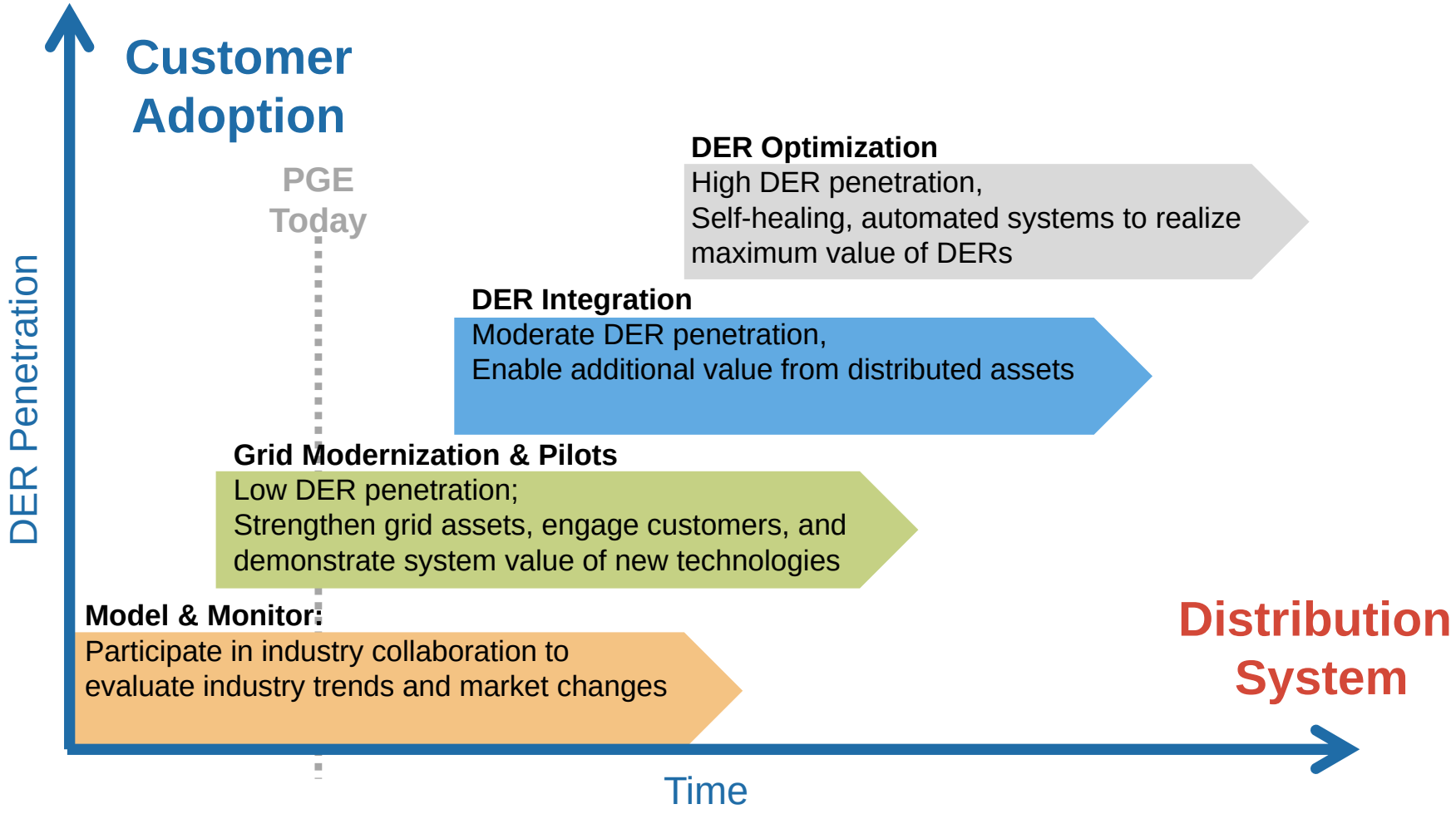


Model & Monitor: leverage industry & customer trends, data, policies, and system modeling, to plan ahead by identifying potential pilots, demonstrations and programs

Engage: incorporate customer and stakeholder feedback as we start small in our deployment and testing of new technologies and programs

Integrate: build upon our foundation as we move to scale on proven technologies that drive new customer value

Distribution System Evolution



Current Landscape

79 MW_{DC}
PV on distribution system

717 MW
Wind Generation

13 MW / 107 MW
Enabled Demand Response &
Dispatchable Standby Generation

1.25 MWh
Available Energy Storage

7,000
EVs in service territory

865
Public EV Charging Stations

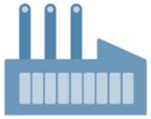
2,600
Integrated Customer Devices

75 / 0.48
Reliability: SAIDI / SAIFI*

One View of the Future

79 ➡ Over 220 MW_{DC}
PV on distribution system

717 ➡ Over 2,000 MW
Wind Generation



13 / 107 ➡ 250 MW / 150 MW
Enabled Demand Response &
Dispatchable Standby Generation

1.25 ➡ 100 MWh
Available Energy Storage

7,000 ➡ 200,000
EVs in service territory

865 ➡ 6,500
Public EV Charging Stations

2,600 ➡ 100,000
Integrated Customer Devices

75 / 0.48 ➡ < 75 / 0.48
Reliability: SAIDI / SAIFI*

Spotlight: Residential Storage Demonstration Project

Key Features

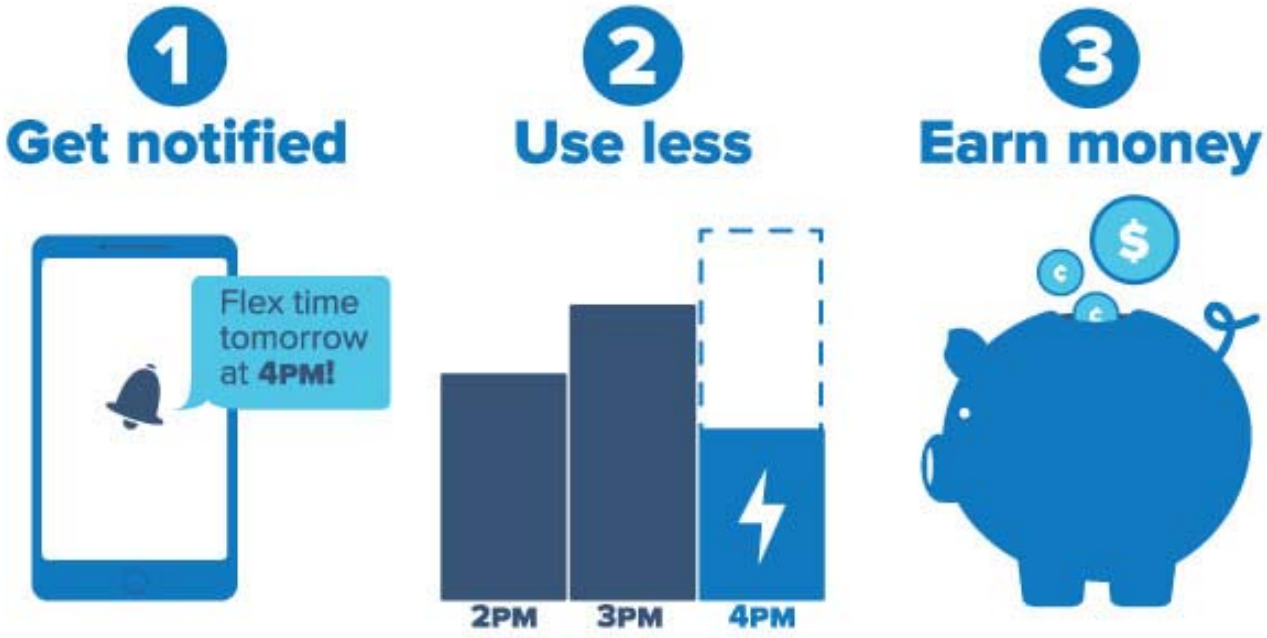
- 25 kWh residential battery in a single family home in Milwaukie, OR
- Aquion (salt-water based) battery technology
- Supports essential needs for a day
- Partnership with Portland State University

Demonstrates how customer-sited storage can provide backup power, peak shifting and grid services. During outages, the battery-inverter system (BIS) isolates from the service panel and grid.

Spotlight:
Flex Pricing Pilot

Evaluating system impacts and customer satisfaction of three program types: time of use, peak time rebates, and behavioral demand response.

- Launched summer 2016
- 3,800 customers enrolled on peak time rebates & time of use
- 6 events called

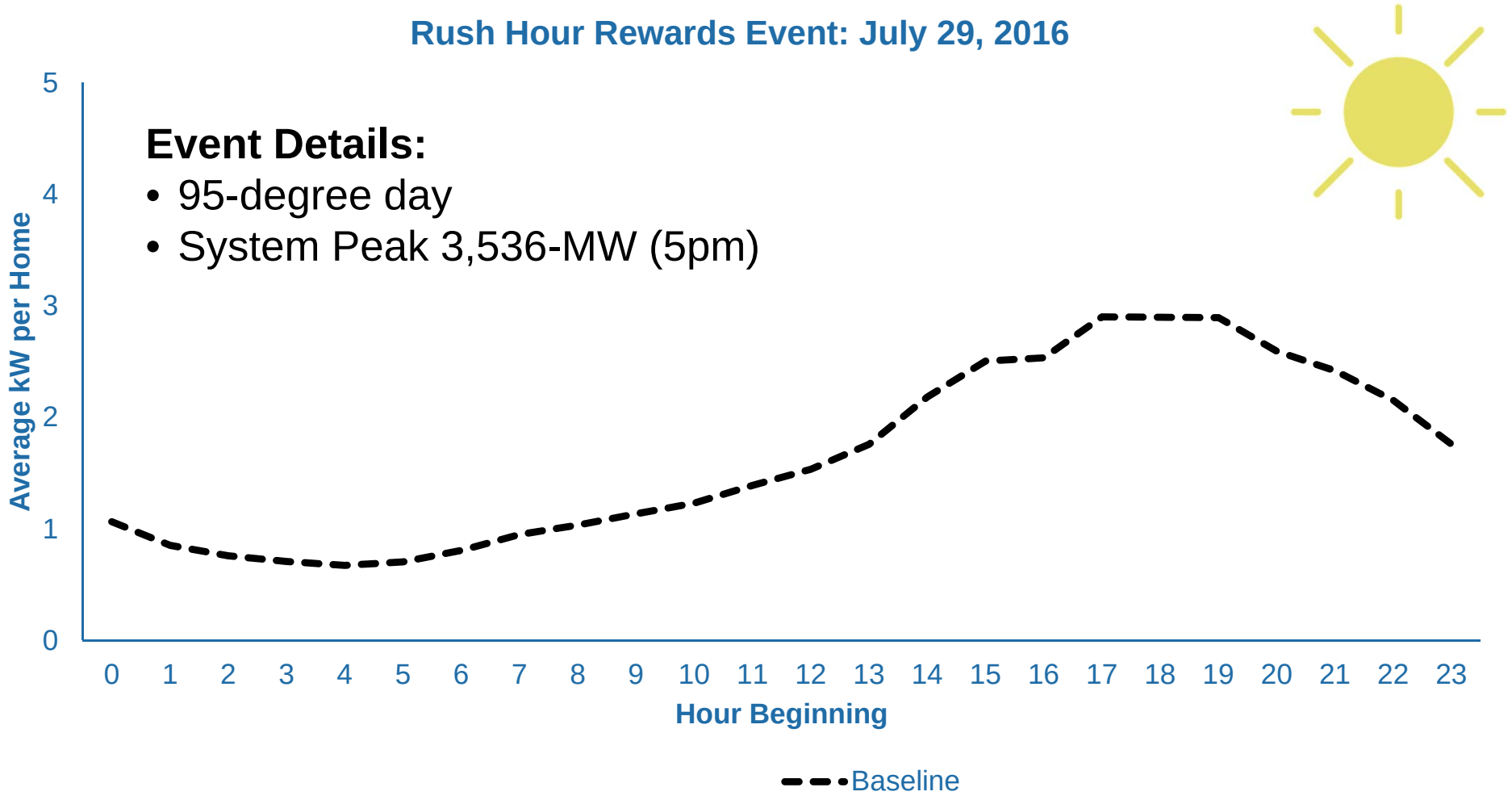


Spotlight: Rush Hour Rewards

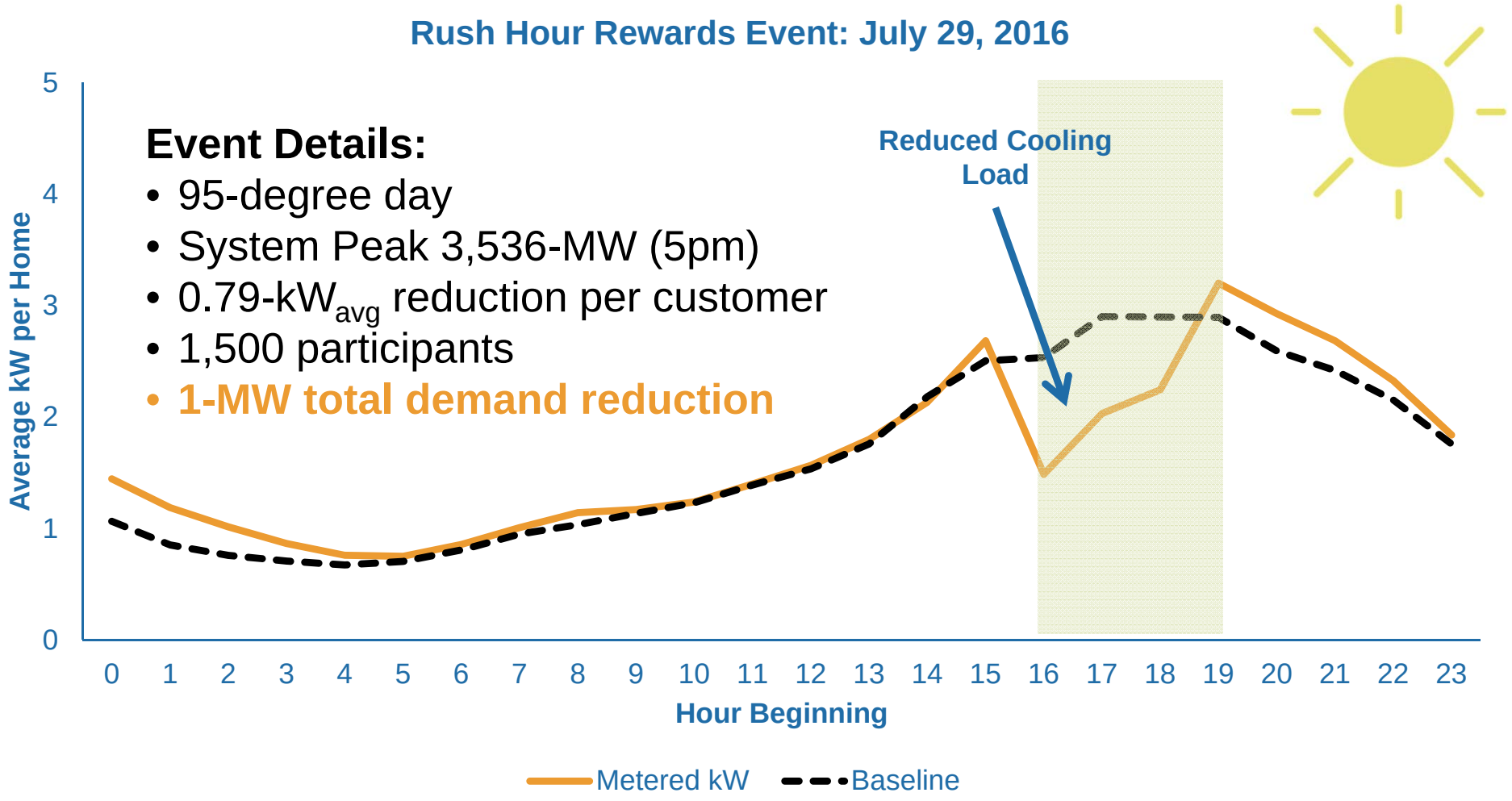
- Smart thermostat demand response pilot
- Launched **Nest's first winter program** in 2015
- **2,600** Nest thermostats enrolled
- Average 0.8-kW/customer demand response achieved in Summer 2016 with **10 events** called

Photo Attribution: Nest.com

Spotlight: Rush Hour Rewards



Spotlight: Rush Hour Rewards



Transportation Electrification Preliminary Pilot Portfolio

Electric Mass Transit 2.0

Outreach & Education

Community Charging Infrastructure

Research & Development

OPUC Staff 2016 Smart Grid Report Actions

1. Provide results of the cost effectiveness evaluation of the Energy Partner Pilot

2. Provide copies of new or updated DSM and DER marketing material with next report.

3. Stakeholder process to compare cost-effectiveness methodologies across all current and future DER and DSM efforts.

4. Provide data on pricing & DR pilot programs.

5. Identify and discuss the resources necessary to evaluate value of DERs to customers and to commence distribution resource planning.

6. Participate in workshop process to discuss changes to the smart-grid reporting process.

Source: Staff Report (10/7/16)

Questions?


FlexNet
35512857
240V 30TA 1Kh FM2S 60Hz
Portland General Electric
22 266 672

Next Steps

Franco Albi

Ongoing IRP Engagement

Continuous dialogue and development

Active Engagement	• Inclusive and accessible process • Meaningful and practical dialogue
Build Knowledge	• Information sharing and education • Lines of communication open continuously
Understand Perspective	• Develop opportunities • Identify innovative alternatives

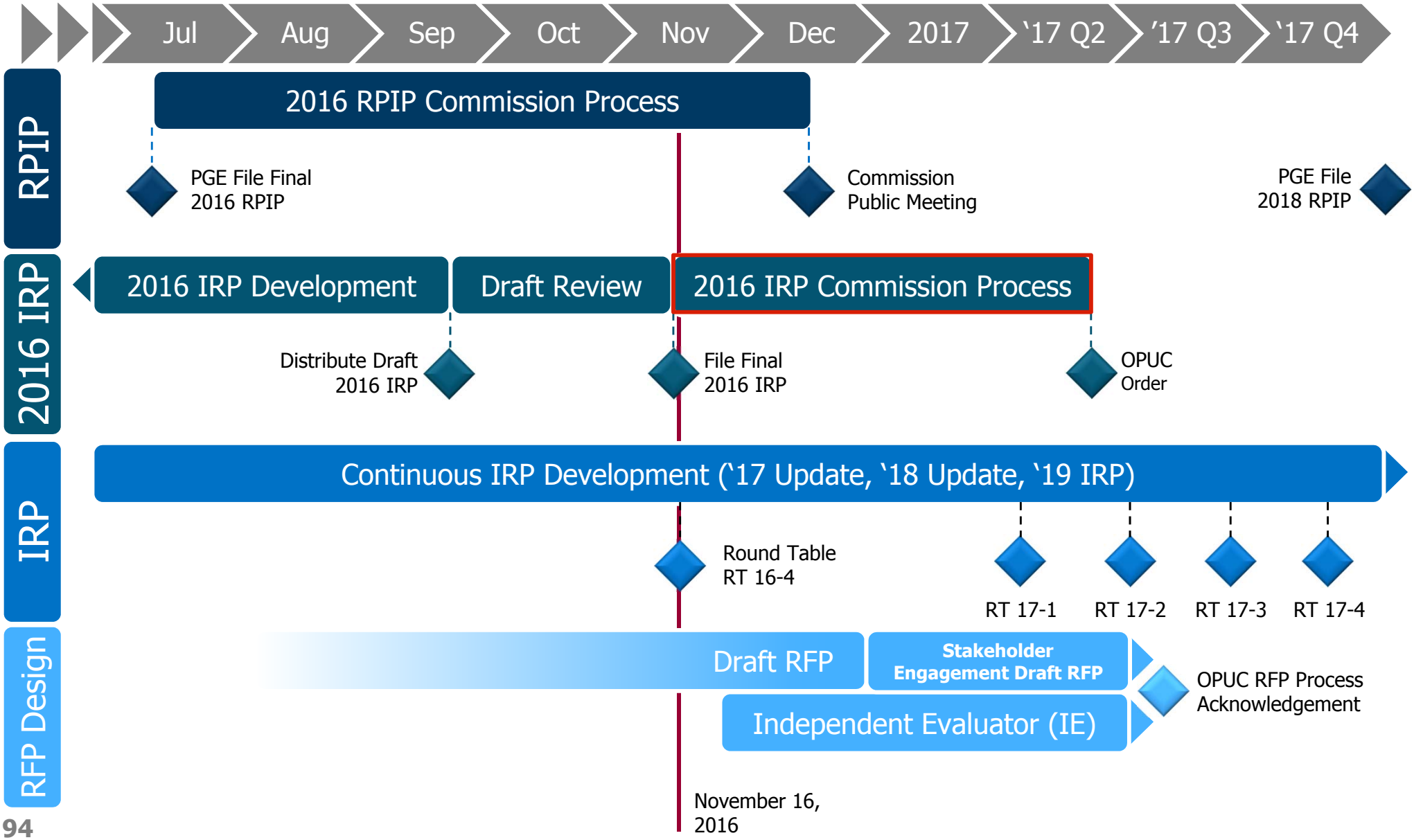
Future IRP development

- Improve upon successful 2016 process
- Continuous evaluation of information

Feedback welcome 24/7 at: https://www.portlandgeneral.com/forms/pge-stakeholder-feedback

Timelines

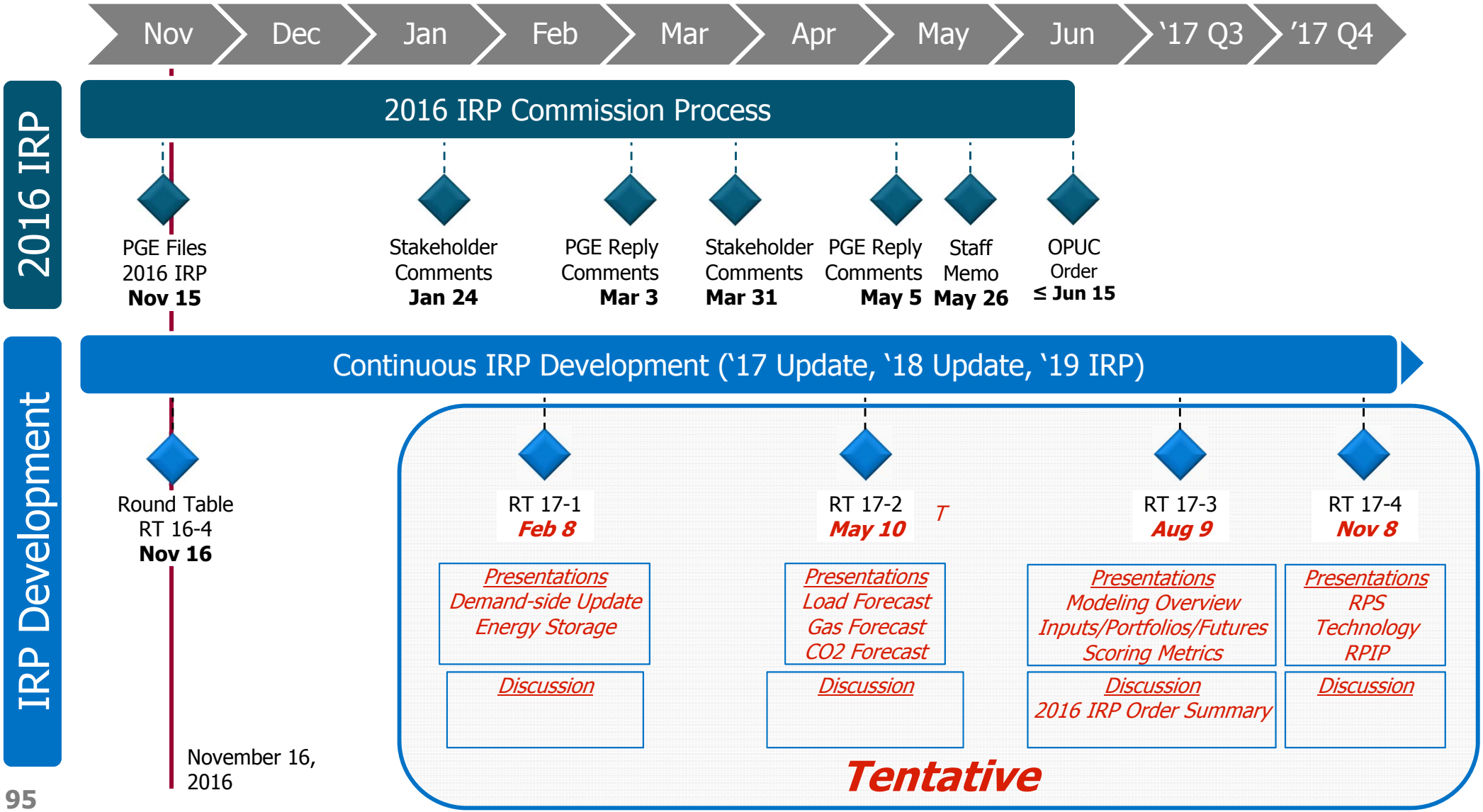
Aligned processes enable transparent communication



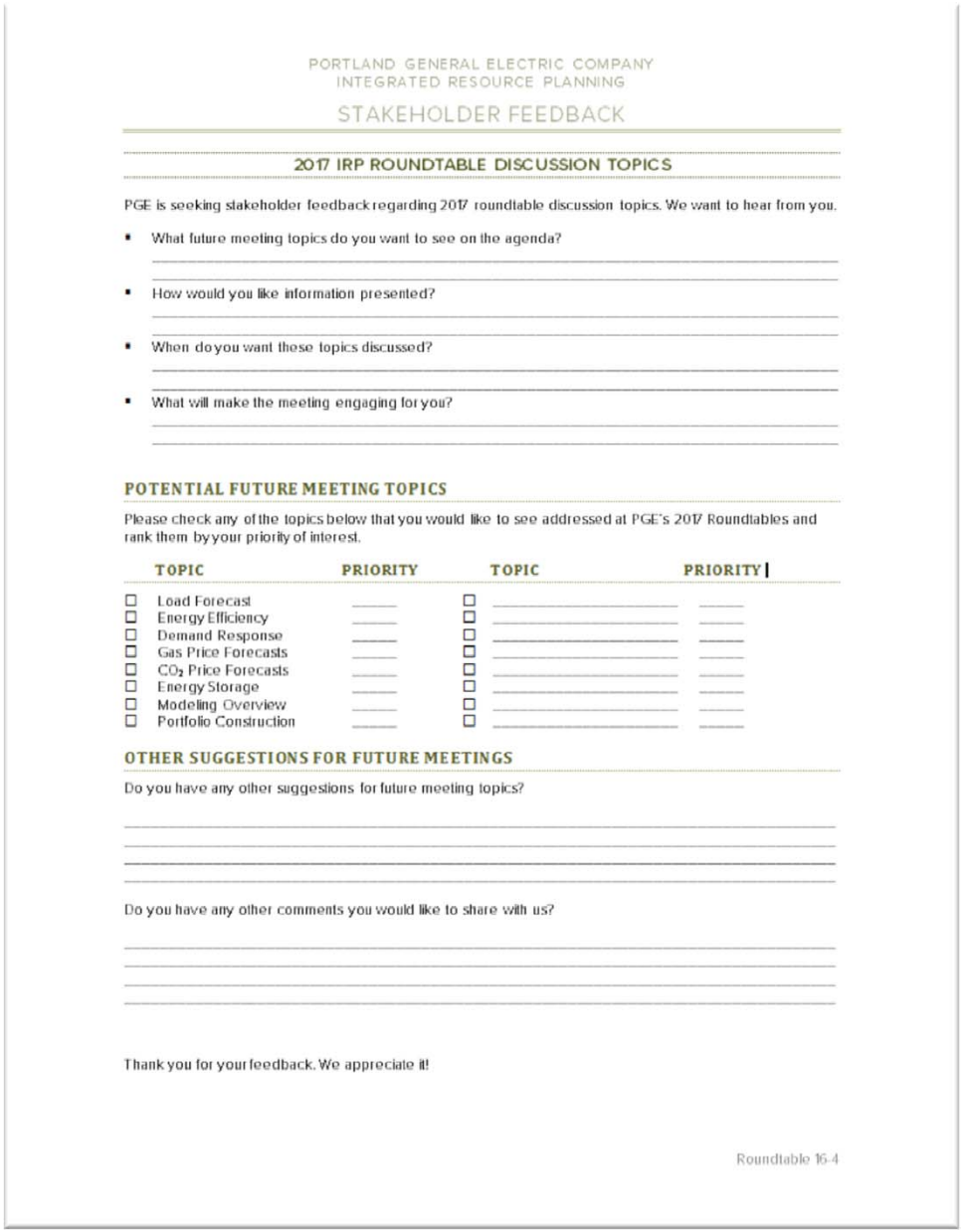
2016 IRP and Development Timelines

Portland General Electric

Parallel OPUC procedure and IRP development



2017 Roundtable Topics



PORTLAND GENERAL ELECTRIC COMPANY
INTEGRATED RESOURCE PLANNING

STAKEHOLDER FEEDBACK

2017 IRP ROUNDTABLE DISCUSSION TOPICS

PGE is seeking stakeholder feedback regarding 2017 roundtable discussion topics. We want to hear from you.

- What future meeting topics do you want to see on the agenda?
- How would you like information presented?
- When do you want these topics discussed?
- What will make the meeting engaging for you?

POTENTIAL FUTURE MEETING TOPICS

Please check any of the topics below that you would like to see addressed at PGE's 2017 Roundtables and rank them by your priority of interest.

TOPIC	PRIORITY	TOPIC	PRIORITY
☐ Load Forecast		☐	
☐ Energy Efficiency		☐	
☐ Demand Response		☐	
☐ Gas Price Forecasts		☐	
☐ CO_2 Price Forecasts		☐	
☐ Energy Storage		☐	
☐ Modeling Overview		☐	
☐ Portfolio Construction		☐	

OTHER SUGGESTIONS FOR FUTURE MEETINGS

Do you have any other suggestions for future meeting topics?

Do you have any other comments you would like to share with us?

Thank you for your feedback. We appreciate it!

Roundtable 16-4

Continuous dialogue increases value

PGE is seeking your input to improve our 2017 roundtable discussions

- Presentation topics
- Areas of discussion
- Meeting format
- Communication suggestions

Thank You!

Feedback welcome 24/7 at:

- https://www.portlandgeneral.com/forms/pge-stakeholder-feedback
- www.portlandgeneral.com/irp
- irp@pgn.com

2016 IRP Feedback Roundup

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
General	Passing the mic was cumbersome.	For stakeholder questions, provide a stationary microphone at a podium or mics at each table.	4/13/2015
Process	Why is schedule different on handout?	Update schedule slides to account for automation. Plan to revise and post updated slide deck to website and include summary update in 'thank you' email.	4/9/2015
Process	Is schedule firm or can the November 18th date be adjusted? (Power Council has important meeting on November 18)	Moved IRP meeting to November 20th.	4/9/2015
Process	Can the October 23rd date be adjusted? (CUB has important meeting on October 23)	Moved IRP meeting to October 21st.	4/9/2015
Environmental Policy	Why will climate data set be a scenario instead of a base case?	PGE to consider suggestion after vetting data.	9/25/2015
Environmental Policy	Does PGE place any type of weather weighting on load forecast?	PGE uses 15-year average weather, with rolling updates	7/15/15

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
Load Forecast Methodology	For future discussion, how is the ETO forecast in later years developed?	PGE to address questions about EE projection in the future. Refer to April 2nd Slide 31.	7/15/15 and 7/16/15
Load Forecast Methodology	Comment on in-fill vs. suburban sprawl – suggestion to be cautious about moving to more standard household variables	PGE to take note.	4/8/2015
Load Forecast Methodology	Request to show load growth with and without EE.	PGE to meet this request.	8/13/2015
Load Forecast Methodology	What % of PGE service territory is within the urban growth boundary?	90% of the UGB is within PGE Service Territory UGB is 822.7 sq. mi. PGE SVC Territory is 7532.2 sq. mi. Overlap is 741.6 sq. mi.	4/8/2015
Environmental Policy	Will temperature data drive (1) increased cooling demand and (2) an acceleration of cooling device purchases?	PGE to follow-up internally with load forecast staff.	Est. 8/13/2015 (with scenarios and climate change weather discussion)

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
Demand Response	How is PGE using the convergence of EE and DR programs, and avoiding over-counting benefits?	PGE is engaging the ETO on a number of DR programs, particularly with Energy Partner and the smart thermostat pilot. Our current plan is to only attribute incremental demand reductions (after EE) to the DR programs. This may change in the future if a more integrated program was offered. In either case, only measured impacts are used and therefore we should not see double counting.	Ongoing
Demand Response	What happened to the EV charging pilot?	The manufacturing of the twenty CEA-2045-equipped smart EVSEs [EV chargers] was delayed. Ten are for PGE and ten for another utility in the EPRI project. PGE now expects delivery in Q1 of 2016 and when we get them we intend to install them at employee homes and systematically test the smart features.	Q1 2016
Demand Response	What is the preferred method of evaluating the cost effectiveness of DR in Oregon?	PGE will be engaging stakeholders in 2016 as part of the larger integrated (smart) grid report process. At a high level, our preferred approach is to look at both total resource and utility cost tests when assessing cost effectiveness.	12/17/15

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
Demand Response	Would PGE provide a copy of the DR study, along with the assumptions (particularly materials supporting the basis for electric heating load control)?	PGE uploaded the final report to portlandgeneral.com	02/16/16
Flexible Capacity Study	Rather than focusing on how renewable curtailment can reduce the trough of the duck, can PGE assess how to change the slope of the neck? (Reference- "Teaching the Duck to Fly")	Our goal is to begin exploring the potential role that energy storage may play with respect to flexibility challenges in this IRP.	12/17/15
Flexible Capacity Study	Can the Flexible Capacity Study include a range of CO2 prices?	At this point, the flexible capacity modeling effort will likely not consider a range of CO2 prices.	12/17/15

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
Futures	Can there be discussions about the Clean Power Plan and mass vs. rate-based modeling?	PGE is willing to host detailed modeling discussions; we look forward to receiving detailed feedback regarding the specific aspects that stakeholders would like to discuss.	12/17/15
Portfolios	How will the results of the Flexible Capacity Study inform portfolio scoring? How will REFLEX work with Aurora to help PGE insure that each type of capacity is appropriately valued?	PGE is willing to host detailed modeling discussions; we look forward to receiving detailed feedback regarding the specific aspects that stakeholders would like to discuss.	12/17/15
Portfolios	Stakeholders would like to see portfolios that intuitively account for the geographical diversity of renewables (i.e., better examples than Gorge wind).	Our goal is for the resource portfolios tested in this IRP to include aspects of diversification benefits of renewable resources.	12/17/15

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
PRM Study	What is PGE's definition of dependable hydro capacity or what does it mean in this context? What method was used to create PGE's estimates?	The definition is dependent on the particular capacity assessment question. PGE presented an overview of the treatment of hydro capacity in the Dec 17 Public Meeting. PGE is willing to host a more detailed technical discussion.	12/17/15
PRM Study	When will PGE share the other portions of the reliability assessment (in addition to the statistics presented at the meeting)?	PGE plans to use the results of the PRM study in the 2016 IRP without other adjustments applied.	12/17/15
PRM Study	How will risk adjustment measures fit in with the PRM study?	PGE plans to use the results of the PRM study in the 2016 IRP without other adjustments applied.	12/17/15
PRM Study	What was the market import assumption?	The import assumption was 200 MW, excluding summer On-peak hours.	12/17/15

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
PRM Study	Can PGE provide clarification on the net capacities used in winter and summer?	The plant capacities were discussed in the 12/17/15 Public meeting.	12/17/15
PRM Study	Why does DSM not change from winter to summer?	As in the 2013 IRP, the PRM Study models the same quantity of demand response (DR) in the winter as in the summer.	12/17/15
PRM Study	Can energy efficiency be pulled out of load forecast and shown as a capacity resource?	EE cannot be removed from load and shown as a resource in the PRM Study for this IRP cycle. PGE is willing to investigate options for future cycles, but due to the relationship between EE and load, there may be impacts to the quality of the results.	12/17/15
Wind Integration	How does the wind integration study intersect with an EIM?	There is no explicit modeling of the EIM in the wind integration study. The study, however, does assume liquid market transactions every 15 minutes.	12/17/15

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
Clean Power Plan	Is PGE going to treat Carty as an existing resource? Can PGE provide the correspondence between PGE and EPA regarding Carty?	Yes. PGE's correspondence with EPA regarding Carty is ongoing. PGE is willing to share the letter dated September 7, 2015, with stakeholders on request.	12/17/15
Clean Power Plan	Does PGE have a preferred state plan option?	PGE prefers a sub-category specific rate based standard.	12/17/15
Clean Power Plan	Is there a more detailed analysis about PGE's Montana obligations with respect to Colstrip 3 and 4?	No. Detailed analysis will be performed in the 2016 IRP.	12/17/15
Clean Power Plan	What will the new emphasis be between mass-based and rate-based futures? Does PGE know the ratio of studied mass-based vs. rate-based scenarios?	PGE will study both rate and mass based implementation plans. PGE does not yet know the ratio of mass to rate based scenarios.	12/17/15

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
Climate Study	Can the report be provided to stakeholders?	Yes. The report will be included in the 2016 IRP.	Est. 7/29/2016
Climate Study	Is the study providing information about plant cooling requirements? Transmission interruptions from wild fires? Higher temperature implications for transformers and line capacities?	No. The focus of the report is the forecasted change of temperatures in the Portland metropolitan area.	12/17/2015
2016 IRP Schedule	At the last public meeting (9/25/15), the schedule showed the draft IRP was planned to be filed at the end of Q1 and the final was to be complete by the end of Q2. Now the schedule is for a draft July 29th and final Sept 16th. What was the reasoning behind this change?	The schedule provided at the September 25th meeting was a preliminary schedule and did not include the filing of a 2013 IRP Update. The work done to complete the update, along with the time needed to finish the 2016 analysis and complete internal PGE reviews, required an adjustment to the 2016 IRP draft release and filing dates. It is important to note that the filing schedule is ahead of the December 2016 due date for the 2016 IRP.	05/16/2016

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
Load Forecast	Commercial growth rate appears to be much greater (1.3%) than residential according to the April 2015 presentation (slide 10). What part of this was smaller commercial?	PGE forecasted commercial energy growth rate of 0.9% (presented at the June 2015 load forecast workshop, slide 14) reflects growth in secondary delivery voltage service, of which small commercial (defined as service < 30 kw, PGE current rate schedule 32 in PGE UE 294/1402/page 2) has historically been approximately 21% of energy deliveries and 84% of customer count. PGE forecasts long-term energy deliveries and customer count by delivery voltage service level and does not have specific forecasted growth rates for more disaggregated customer segments.	03/09/16

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
Load Forecast	PGE's service territory experienced stronger economic growth in 2014 and 2015 than was predicted in the economic forecast used as an input assumption for the initial 2013 IRP filing. p 18. What part of that was in the smaller commercial?	PGE tracks economic indicators such as the unemployment rate, unemployment claims, employment levels and growth by industry sector and building permits for the state of Oregon and counties within PGE service territory. PGE's source for regional economic outlook, the Oregon Office of Economic Analysis, does not provide forecasts of employment disaggregated by business size needed to determine which size groups exceeded expectations, nor does PGE track specific data on economic growth indicators by business size. The Oregon Employment Department periodically reports annual data on Oregon employment by business size which can be found online: https://www.qualityinfo.org/-/portrait-of-oregon-businesses-by-size-of-firm.	03/09/16

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
Energy Conservation	PGE continues to work with the ETO to achieve the targeted energy efficiency savings. (IRP Update page 12). What conversations are specific to small commercial?	PGE collaborates with the Energy Trust to increase customer awareness and participation in Energy Trust small to mid-sized commercial energy efficiency programs through outreach and marketing activities. PGE has a three outreach specialists who work directly with small business customers. Outreach specialists provide small commercial customers with energy efficiency consultations and connect them with Energy Trust Trade allies. Business community outreach is supplemented with targeted marketing and through small business customer newsletters. PGE coordinates its outreach activity with Energy Trust though regular meetings. PGE and Energy Trust identified challenges in increasing Energy Trust participation rates among small business customers. In response to the challenge, Energy Trust recently created a new lighting program for small business customers which includes increased incentives and 0% interest financing. PGE is currently supporting the program through its outreach and marketing efforts.	03/09/16
Energy Conservation	How has PGE focused on the smaller commercial customer group to realize potential in conservation through lighting (slide 40 of 140) showing lighting as highest potential for conservation (e.g. 500,000 MW cost effective potential)?	PGE primarily focuses on lighting projects in the activities described below due to the potential and cost effectiveness for lighting projects.	03/09/16

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
Energy Conservation	How has PGE focused on the smaller commercial customer group to realize potential in conservation through lighting (slide 40 of 140) showing lighting as highest potential for conservation (e.g. 500,000 MW cost effective potential)?	PGE primarily focuses on lighting projects in the activities described below due to the potential and cost effectiveness for lighting projects.	03/09/16
Integrated Grid	You note the large number of use cases for the Salem Smart Power project. Initially 6, now 14. The large number is interesting and implies more value to be derived from storage but any analysis/quantification of the end use cases would be valuable to present. What is the timing for having more quantifiable evaluation data available? How do the values compare relative to each other and how has this work helped you quantify values?	PGE has a project with Pacific Northwest National Laboratory, with funding received from the US Department of Energy, to model the financial benefits of the 14 identified use cases. This work will not only provide PGE an understanding of the value of various use cases to each other, but will also model the financial benefits of providing multiple simultaneous use cases, which we expect to improve the overall economics of the energy storage system. This project will begin in Q3 of 2016 and conclude in Q3-Q4 of 2017.	05/16/16

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
Integrated Grid	You mention working with Energy Trust on the Rush Hour Rewards Pilot. Specifically, what has been/will be their role in the pilot?	Energy Trust and PGE are co-marketing the Rush Hour Rewards program with the Energy Trust's smart thermostat rebates. Both parties are providing links to the other's websites/enrollment portals. Energy Trust promotes Rush Hour Rewards on its Smart Thermostat program web page and PGE includes Energy Trust's program information on its website. This will become more important as PGE moves from simply enrolling existing thermostat owners to expanding the base of installed thermostats. Given the quantified efficiency benefits of Nest thermostats in particular (per the evaluations conducted for ETO by Apex Analytics), we feel that this collaboration is a win-win for ETO, PGE, and our customers.	03/06/2016

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
Integrated Grid	What is your estimate per household reduction for the Pricing Pilots for the estimated 3,500-7,000 customers? Why is the range of households participating so large? Which pilot has the most uncertainty in gaining targeted participation?	The uncertainty lies in the opt-in components, in particular time-of-use rates without a peak time rebate component. Preliminary results of initial enrollment show that signing up customers on these rates can be tough and often requires multiple touchpoints before getting to conversion. Additionally, our experimental design for the opt-in components requires a recruit-and-deny approach, meaning we have to over enroll each program and then assign some portion to the control group. We are targeting 3,850 participants for our opt-in rates, but this will require enrolling 6,340 all told. In addition, we will have 13,610 enrolled in opt-out Peak Time Rebates or Behavioral Demand Response.	05/06/2016

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
DR Potential Study	Please share your evaluation of the Energy Partner Pilot. You noted overlap with energy savings and Energy Trust's work. How is energy savings realized at these sites attributed to Energy Partner quantified and reported? Is an Energy Trust program also working with these sites and if so, have interactive effects between programs been addressed?	PGE's year 1 evaluation is available upon request. The final year 2 report will be provided to staff along with our annual report 4/29/16. In general, participants in Energy Partner are industrial customers with load that is simply being shifted to a later time. For this reason, estimation of total energy impacts was not included in the scope of work for the current evaluation. Events occur only a handful of times a year for a few hours and they are not expected to have a large impact on total energy consumption at the annual level. That being said, it may be interesting for Energy Trust to look at differences in energy savings between DR and non-DR participants in their SEM evaluations in the future.	03/09/16

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
Integrated Grid	What does "identifying the system benefit of targeted peak energy usage education…." mean? Does it mean "quantifying"? If so, is the system benefit the actual capacity reduction or is the benefit quantified in dollars?	The evaluation will identify both the benefit both in terms of average peak reductions (our planning estimates are 3% of residential load for behavioral intervention alone) and the monetary value of the avoided capacity investment.	05/16/2016
DR Potential Study	In the High Case for DR Potential, do default TOU and Peak time Rebates replace the opt-in type programs in the low and base cases?	Yes, that is correct.	05/16/2016

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
DR Potential Study	If the High Case programs are cost effective, listing the barriers to acquisition and risk factors and any specific actions that may help overcome those barriers would be helpful. The difference in potential impact is high so it will be necessary to clearly see the barriers and the magnitude of effort/costs for what it would take to overcome the barriers in order to reach that high impact level.	The biggest component that differentiates the high case form the others is the default time-variant rates. We have received feedback from several stakeholders (most recently CUB and ODOE) that they would not be comfortable moving forward with these sorts of programs. The other barrier is simply one of funding and timeline. The high case includes more aggressive participation targets and timelines that would require a rapid scaling of resources. This would be a departure from the more measured phasing-in of programs that stakeholders have seemed to favor to date.	05/16/2016

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
Resource Adequacy Study	Slide 89 (Public Meeting, 12/17/2015) states that generalizations will be made for capacity needs and capacity contributions for other years and resource combinations. Does this mean that the analysis was done for 2021 only and other years will be estimated based off the 2021 work? Please provide more description as to how this study will be used.	PGE presented data from RECAP runs for 2025 and 2030 in the 03/09/2016 meeting (Roundtable #16-1). The presentation also included capacity need values for all years of the IRP study based on interpolating/extrapolating from the RECAP runs. Interpolations and extrapolations are used to reduce the quantity of model runs that would be needed to cover every year and every combination of resources in those years.	05/16/2016
Resource Adequacy Study	Slide 72 (Public Meeting, 12/17/2015) notes that energy efficiency is in the load forecast. Does the hourly shape (binned hour and day type impacts vs hourly) of the energy savings align with the Energy Trust's updated end use load shapes from the Power Council?	The hourly shape of the energy efficiency in the load forecast is not based on the load shapes from the Power Council.	05/16/16

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
Resource Adequacy Study	Slide 91 (Public Meeting, 12/17/2015), Please add energy efficiency to this list of modeling options for next cycle to be modeled as a resource, not a decrement to load.	PGE discussed this issue in the 12/17/2015 Public Meeting and the 03/09/2016 Round Table. It is on the list to investigate for the next IRP cycle. As discussed, due to modeling issues, it may not be practical to capture energy efficiency as a resource, but it may be possible to use different load scenarios to examine the impacts of different levels of energy efficiency.	05/16/16
Futures & Portfolios	Please clarify assumptions used for market depth for energy and capacity. Recommend limiting the amount of market purchases to a level in line with historical capabilities or justified future market depth projections to provide energy/capacity. For example, in portfolio 1, how does the 961 MW of market capacity compare to historical and estimated future market possible size?	Portfolio 1 is not intended to be representative of forward-going energy or capacity "market depth." Rather, this portfolio serves an analytical baseline from which to judge the relative costs and risks of strategies that are intended to satisfy resource adequacy standards. The assessment of portfolio reliability occurs as an element of the portfolio scoring process.	05/16/2016

2016 IRP: Feedback Status

Topic	Feedback Received	Resolution	Completed
Futures & Portfolios	Generally, why study 2021 for ELCC and 2025 for portfolio coverage? Why the difference?	PGE is studying 2021, 2025, and 2030 for resource adequacy and renewable capacity contribution. Resource portfolio cross-sectional views have been presented at 2021 and 2025 snapshots.	05/16/2016
Futures & Portfolios	Slides 99 and 100 differentiate between Capacity and Summer or Winter capacity. Please explain the difference between the two and how they were determined. Suggest showing capacity needs by having portfolios not reach the capacity need line, not with two blocks (Capacity and either summer or winter capacity)	In PGE's December Public Meeting, we attempted to illustrate the expectation that different resource portfolios contribute to PGE's system capacity differently on a seasonal basis. For example, an incremental portfolio composed primarily of solar resources might contribute more towards system capacity in the summer than the winter, and the opposite might be true for particular wind resources. Please refer to PGE's current resource portfolios for a more streamlined representation of portfolio capacity contribution.	05/16/2016

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Futures & Portfolios	How was this portfolio creation process illustrated in the past and is this current approach meant to be a new approach that addresses concerns from last time?	PGE's portfolio creation process was generally described verbally rather than illustrated visually, and did not consider factors such as ELCC or attempt make distinctions based on seasonal needs or capabilities. I'm unaware of any specific feedback regarding concerns surrounding the portfolio creation process in PGE's prior IRPs.	05/16/2016
Futures & Portfolios	Slide 98 (Public Meeting, 12/17/2015), portfolio 3 shows 600aMW of PNW Wind. This resource then equates to just 127 MW winter VER capacity and 235 MW summer VER capacity. Compare that to portfolio 2 where 243aMW PNW Wind equates to 98 MW winter VER capacity and 111 MW summer VER capacity. For more than 2 times the PNW Wind in energy in portfolio 3 vs portfolio 2, why is the winter capacity contribution in portfolio 3 just 30% more than in portfolio 2?	In general, a given variable resource is expected to provide diminishing marginal contribution to system capacity as increasing quantities are included in a portfolio (the last MW addition contributes less than the first MW addition).	05/16/2016

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Futures & Portfolios	Please describe the methodology used in determining the Capacity needs vs the market needs for slides 99 and 100 (Public Meeting, 12/17/2015).	PGE needs more information to address this question.	05/09/2016
Futures & Portfolios	Consistency in labeling between all three plots would be helpful. VER should remain differentiated by type of wind and solar added (Public Meeting, 12/17/2015)	PGE's approach to estimating the capacity contribution of variable energy resources considers the portfolio of incremental variable resources and does not attempt to parse the contribution of that portfolio back to its constituents.	
Futures & Portfolios	When are scenario discussions scheduled?	PGE has presented the risk factors (Futures) that will be considered in scenario analysis at the August and December IRP Public Meetings. Feedback was sought during those discussions.	12/17/2015

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Futures & Portfolios	Please provide an exploration of how SB 1547 affects resource choices near-term.	The May 16, 2016 presentation will address this feedback.	05/16/2016
Futures & Portfolios	Discuss how later RPS obligations (2025; 2030; 2035; 2040) should influence Boardman replacement choices; as well as how these are affected by Federal tax considerations, the RPS cap on rate increases, etc.	The May 16, 2016 presentation will address this feedback.	05/16/2016
Futures & Portfolios	PGE's scenarios account for fuel cost future variability, how is the Company capturing sensitivities related to wind, solar, and storage technology cost curve variability	The May 16, 2016 presentation will address this feedback.	05/16/2016