TEA
THE EnergyAuthority

Credit Exposure: Public Utility District No. 1 of Benton County, Washington

Counterparty	Agreement Type	Credit Limit	Credit Available	Percent Available	Credit Adj	Collateral	Receivable Balance	Unbilled Rec/ Pay	Fwd Physicals	Fwd Financials	Credit Exposure	S&P Rating
American Electric Power Service	Corporation	$2,250,000	$2,250,000			$0						BBB
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
Arizona Public Service Company		$1,912,500	$1,912,500			$0						A-
	WSPP	-	$1,912,500	100.00%	-	$0	-	-	$0	-	-	
Avangrid Renewables, LLC			$100,000			$100,000						
	ISDA w/ Pwr Anx	-	$100,000	100.00%	-	$0	-	-	$0	-	-	
	TRNC	-	$100,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$100,000	100.00%	-	$0	-	-	$0	-	-	
Avista Corporation		$1,162,500	$1,162,500			$0						BBB
	TRNC	-	$1,162,500	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$1,162,500	100.00%	-	$0	-	-	$0	-	-	
BP Energy Company			$2,900,000			$2,900,000						
	ISDA	-	$2,900,000	100.00%	-	$0	$0	$0	$0	-$3,044	-$3,044	
	TRNC	-	$2,900,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$2,900,000	100.00%	-	$0	-	-	$0	-	-	
CP Energy Marketing (US) Inc.			$2,000,000			$2,000,000						
	WSPP	-	$2,000,000	100.00%	-	$0	-	-	$0	-	-	
Cargill Power Markets, LLC			$2,250,000			$2,250,000						
	TRNC	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
Chelan County PUD No. 1		$2,250,000	$2,250,000			$0						AA
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	

Counterparty	Agreement Type	Credit Limit	Credit Available	Percent Available	Credit Adj	Collateral	Receivable Balance	Unbilled Rec/ Pay	Fwd Physicals	Fwd Financials	Credit Exposure	S&P Rating
Citigroup Energy Inc.			$2,250,000			$2,250,000						
	ISDA w/ Pwr Anx	-	$2,250,000	100.00%	-	$0	$0	$4,545	$0	-$25,226	-$20,681	
	TRNC	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
City of Seattle, by and through its City Light Dept		$2,250,000	$2,250,000			$0						AA
	TRNC	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
Clatskanie People's Utility District		$1,031,250	$1,031,250			$0						BBB+
	TRNC	-	$1,031,250	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$1,031,250	100.00%	-	$0	-	-	$0	-	-	
EDF Trading North America, LLC			$0			$0						
	ISDA w/ Pwr Anx	-	$2,250,000	100.00%	-	$2,250,000	$0	$21,408	$0	-$23,634	-$2,226	
Emerald People's Utility District		$2,250,000	$2,250,000			$0						NR
	TRNC	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	Transmission	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
Eugene Water & Electric Board		$2,250,000	$2,250,000			$0						AA-
	TRNC	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
Exelon Generation Company, LLC		$2,250,000	$2,250,000			$0						BBB
	ISDA	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	TRNC	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
FortisBC Energy Inc.		$450,000	$450,000			$0						
	Gas EDI	-	$450,000	100.00%	-	$0	-	-	$0	-	-	
Grant County Public Utility District No. 2		$2,250,000	$2,250,000			$0						AA
	TRNC	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
IGI Resources, Inc.		$0	$100,000			$100,000						
	Gas	-	**$100,000**	0.00%	-	$0	-	-	$0	-	-	

Counterparty	Agreement Type	Credit Limit	Credit Available	Percent Available	Credit Adj	Collateral	Receivable Balance	Unbilled Rec/ Pay	Fwd Physicals	Fwd Financials	Credit Exposure	S&P Rating
Idaho Falls Power		$2,250,000	$2,250,000			$0						
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
Idaho Power Company		$2,250,000	$2,250,000			$0						BBB
	TRNC	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
J. Aron & Company LLC			$2,250,000			$2,250,000						
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
JP Morgan Ventures Energy Corporation			$2,250,000			$2,250,000						
	ISDA	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
LL&P Wind Energy, Inc.		$500,000	$500,000			$0						
	Power	-	$500,000	100.00%	-	$0	-	-	$0	-	-	
Macquarie Energy, LLC			$0			$0						
	ISDA w/ Pwr Anx	-	$2,067,777	96.18%	-	$2,150,000	$0	$48,410	$0	$33,813	$82,223	
Morgan Stanley Capital Group, Inc.			$2,156,602			$2,250,000						
	ISDA	-	$2,156,602	95.85%	-	$0	$0	-$7,284	$0	$100,682	$93,398	
	TRNC	-	$2,156,602	95.85%	-	$0	-	-	$0	-	-	
	WSPP	-	$2,156,602	95.85%	-	$0	-	-	$0	-	-	
NorthWestern Corporation d/b/a NorthWestern Energy		$562,500	$562,500			$0						BBB
	TRNC	-	$562,500	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$562,500	100.00%	-	$0	-	-	$0	-	-	
PacifiCorp		$3,000,000	$3,000,000			$0						A-
	TRNC	-	$3,000,000	100.00%	-	$0	-	-	$0	-	-	
	Transmission	-	$3,000,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$3,000,000	100.00%	-	$0	-	-	$0	-	-	
Pacific Northwest Generating Cooperative		$2,250,000	$2,250,000			$0						
	TRNC	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	

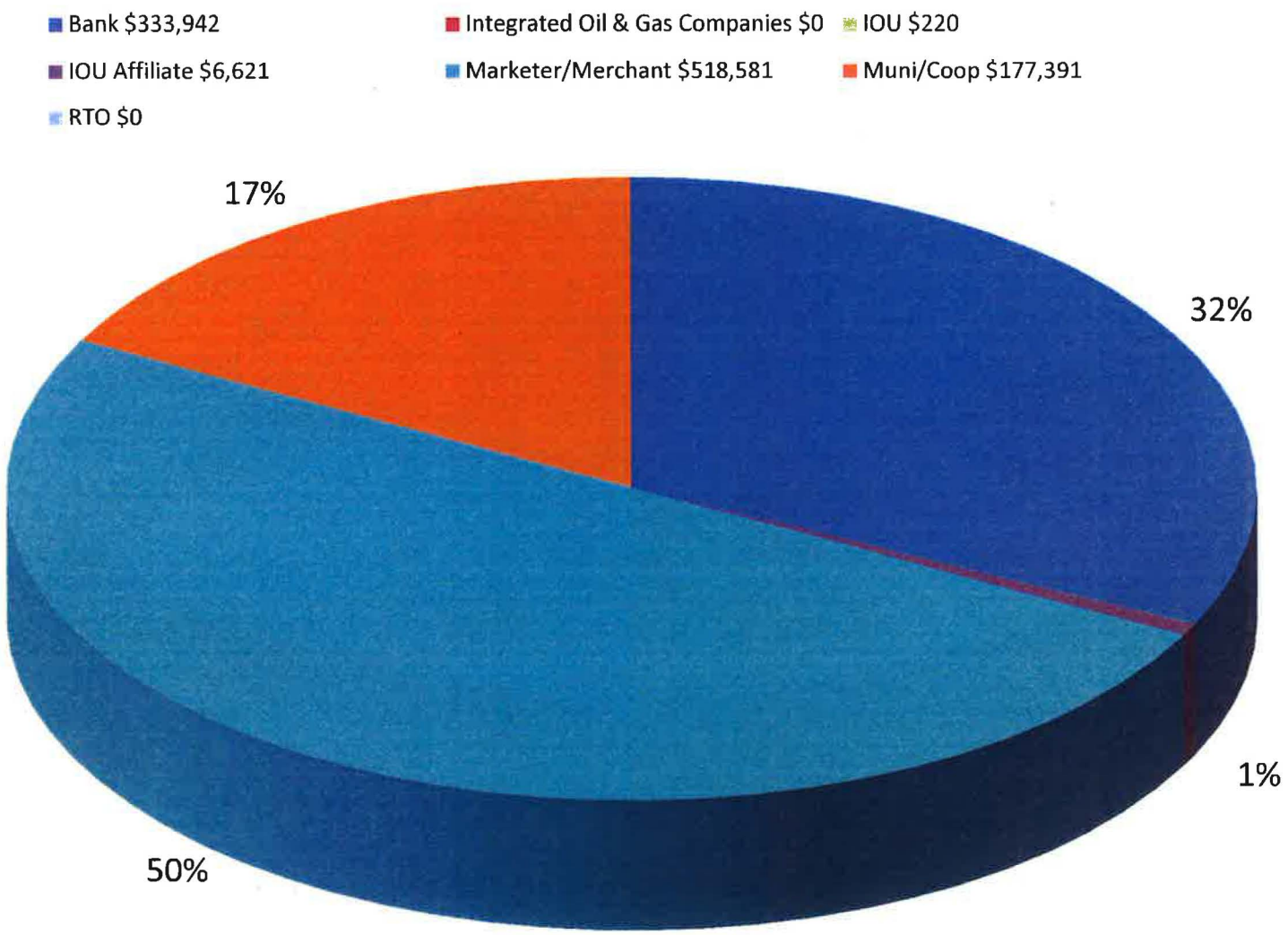
Counterparty	Agreement Type	Credit Limit	Credit Available	Percent Available	Credit Adj	Collateral	Receivable Balance	Unbilled Rec/ Pay	Fwd Physicals	Fwd Financials	Credit Exposure	S&P Rating
Portland General Electric Company		$2,250,000	$2,250,000			$0						BBB
	TRNC	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
Powerex Corp.			$1,312,500		$0	$1,312,500						
	ISDA	-	$1,312,500	100.00%	-	$0	-	-	$0	-	-	
	NAESB	-	$1,312,500	100.00%	-	$0	$0	-$225,719	$0	$0	-$225,719	
	TRNC	-	$1,312,500	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$1,312,500	100.00%	-	$0	-	-	$0	-	-	
Public Service Company of Colorado		$2,103,750	$2,103,750			$0						A-
	WSPP	-	$2,103,750	100.00%	-	$0	-	-	$0	-	-	
Public Utility District No. 1 of Clark County, Washington		$2,250,000	$2,250,000			$0						
	TRNC	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
Public Utility District No. 1 of Cowlitz County, Washington		$2,250,000	$2,250,000			$0						NR
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
Public Utility District No. 1 of Franklin County, Washington		$2,250,000	$2,250,000			$0						A
	TRNC	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	Transmission	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
Public Utility District No. 1 of Grays Harbor County, Washington		$2,250,000	$2,250,000			$0						A
	TRNC	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	Transmission	-	$2,250,000	100.00%	-	$0	$0	$0	$0	$0	$0	
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
Public Utility District No. 1 of Klickitat County, Washington		$1,875,000	$1,875,000			$0						BBB+
	Power	-	$1,875,000	100.00%	-	$0	-	-	$0	-	-	
	TRNC	-	$1,875,000	100.00%	-	$0	-	-	$0	-	-	
	Transmission	-	$1,875,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$1,875,000	100.00%	-	$0	-	-	$0	-	-	

Counterparty	Agreement Type	Credit Limit	Credit Available	Percent Available	Credit Adj	Collateral	Receivable Balance	Unbilled Rec/ Pay	Fwd Physicals	Fwd Financials	Credit Exposure	S&P Rating
Public Utility District No. 1 of Lewis County, Washington		$2,250,000	$2,250,000			$0						
	TRNC	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
Public Utility District No. 1 of Snohomish County		$2,250,000	$2,250,000			$0						AA-
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
Public Utility District No. 2 of Pacific County, Washington		$2,250,000	$2,250,000			$0						
	TRNC	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
Public Utility District No. 3 of Mason County		$656,250	$655,180			$0						A+
	WSPP	-	$655,180	99.84%	-	$0	$0	$1,038	$32	$0	$1,070	
Puget Sound Energy Inc.		$2,250,000	$2,250,000			$0						BBB
	NAESB	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	TRNC	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
Rainbow Energy Marketing Corporation			$0			$0						
	WSPP	-	$50,000	0.00%	-	$50,000	-	-	$0	-	-	
Sacramento Municipal Utility District		$2,250,000	$2,250,000			$0						AA-
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
Shell Energy North America (Canada), Inc.		$100,000	$100,000			$0						
	NAESB	-	$100,000	100.00%	-	$0	-	-	$0	-	-	
Shell Energy North America (US), L.P.		$2,150,000	$2,150,000			$0						A-
	ISDA	-	$2,150,000	100.00%	-	$0	-	-	$0	-	-	
	TRNC	-	$2,150,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$2,150,000	100.00%	-	$0	-	-	$0	-	-	
Tacoma Power		$2,250,000	$2,250,000			$0						AA
	Transmission	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$2,250,000	100.00%	-	$0	-	-	$0	-	-	
Tenaska Marketing Ventures			$0			$0						
	NAESB	-	$1,893,750	100.00%	-	$1,893,750	-	-	$0	-	-	

Counterparty	Agreement Type	Credit Limit	Credit Available	Percent Available	Credit Adj	Collateral	Receivable Balance	Unbilled Rec/ Pay	Fwd Physicals	Fwd Financials	Credit Exposure	S&P Rating
Tenaska Power Services Company			$1,893,750			$1,893,750						
	TRNC	-	$1,893,750	100.00%	-	$0	-	-	$0	-	-	
	Transmission	-	$1,893,750	100.00%	-	$0	-	-	$0	-	-	
	WSPP	-	$1,893,750	100.00%	-	$0	-	-	$0	-	-	
The Energy Authority, Inc.		$4,000,000	$3,479,124		$0	$0						
	Acct RMA	-	$3,479,124	86.98%	-	$0	$0	$444,028	$0	$0	$444,028	
	Transmission	-	$3,479,124	86.98%	-	$0	$0	$74,841	$0	$2,007	$76,848	

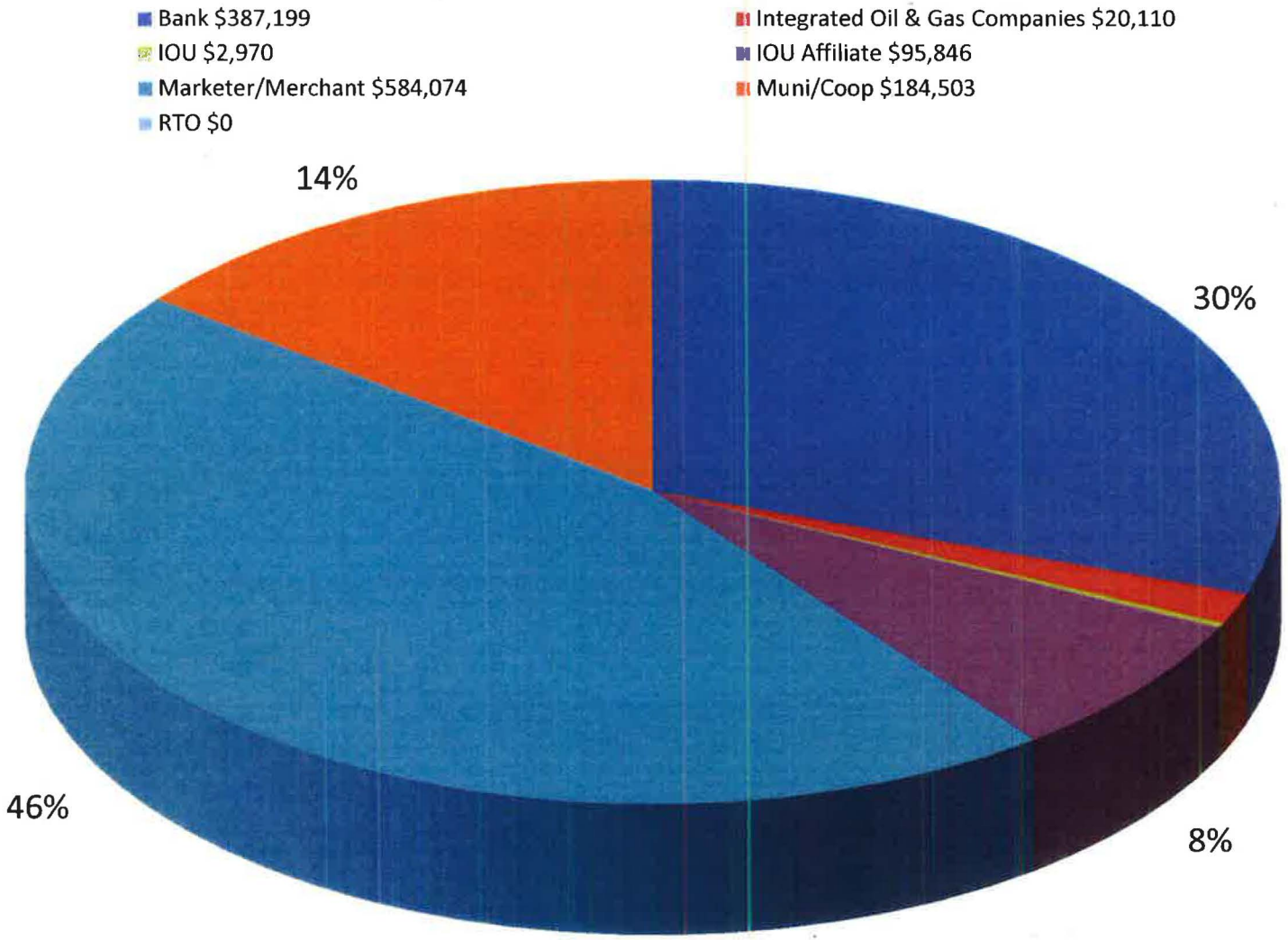
BCPD:51545:2017:031:040558

Benton PUD Credit Exposure by Sector as of October 31, 2017



Benton's total exposure (principal and agent) is $1,036,755

Benton PUD Credit Exposure by Sector as of September 30, 2017



Benton's total exposure (principal and agent) is $1,274,702

2018-2019 Conservation Budget Plan

Your Trusted Energy Partner

Commission Presentation

November 14, 2017

BENTON P·U·D

RP3 Reliable Public Power Provider

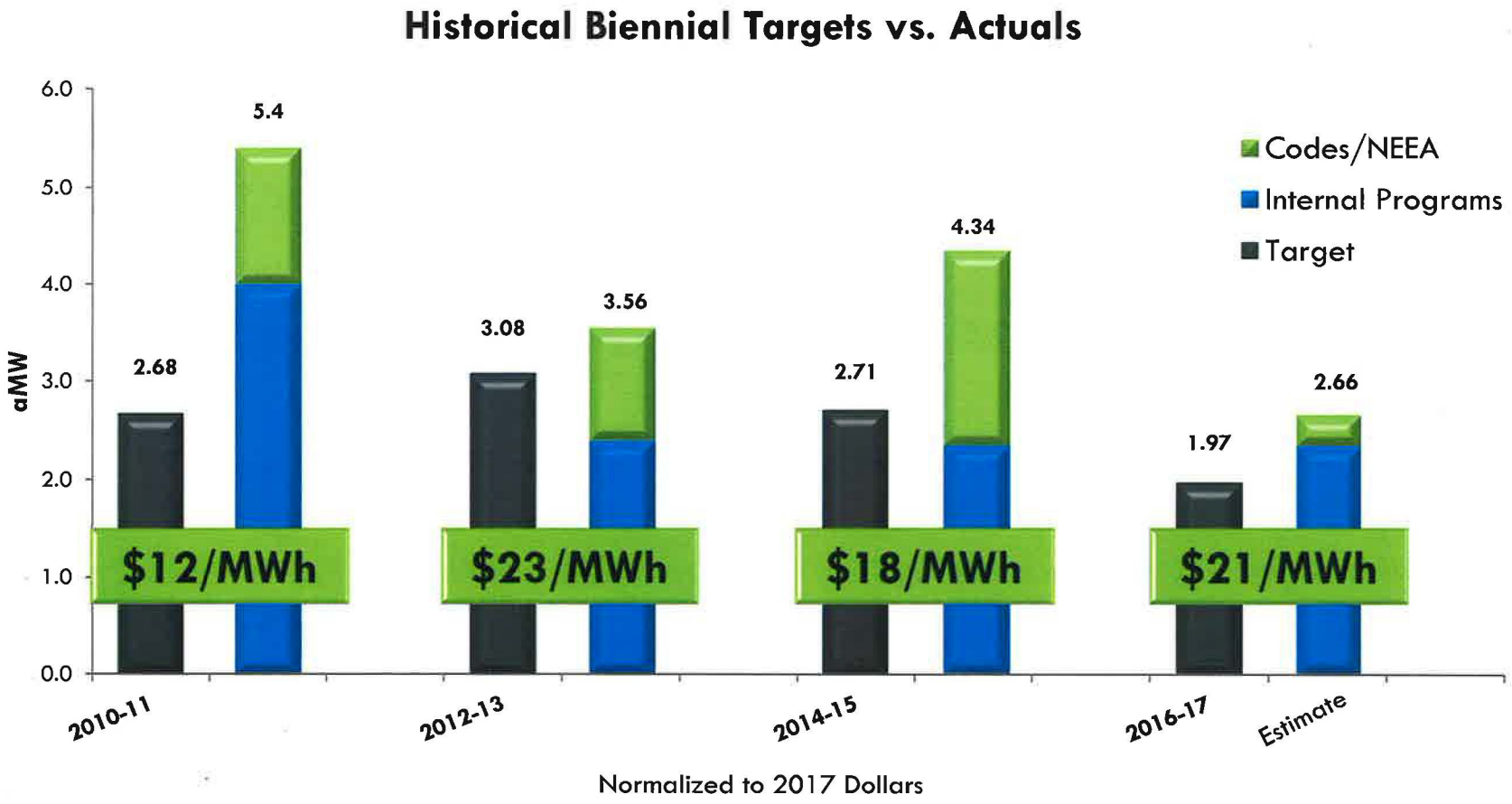
Agenda

- Why Conservation?
- Historical Achievements
- What's Changed?
- 2018-2019 Budget Plan
- Summary
- Questions

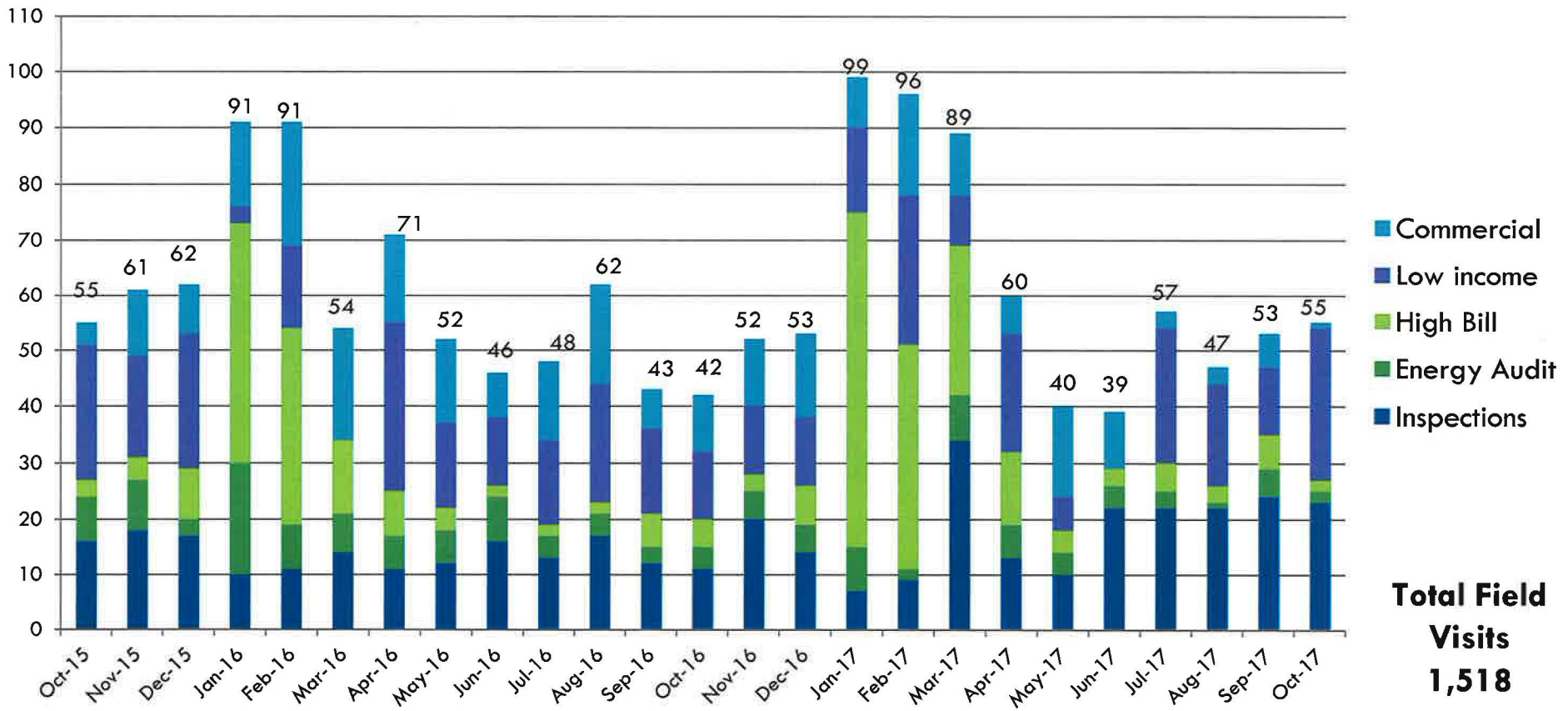
Why Conservation?

- Trusted Energy Partner
  - Offer diverse programs
  - Provide incentives
  - Provide technical expertise
- Meets EIA requirements
- Low cost resource
  - Mitigates portion of District load growth
  - Offsets additional power purchases

Historical Achievements



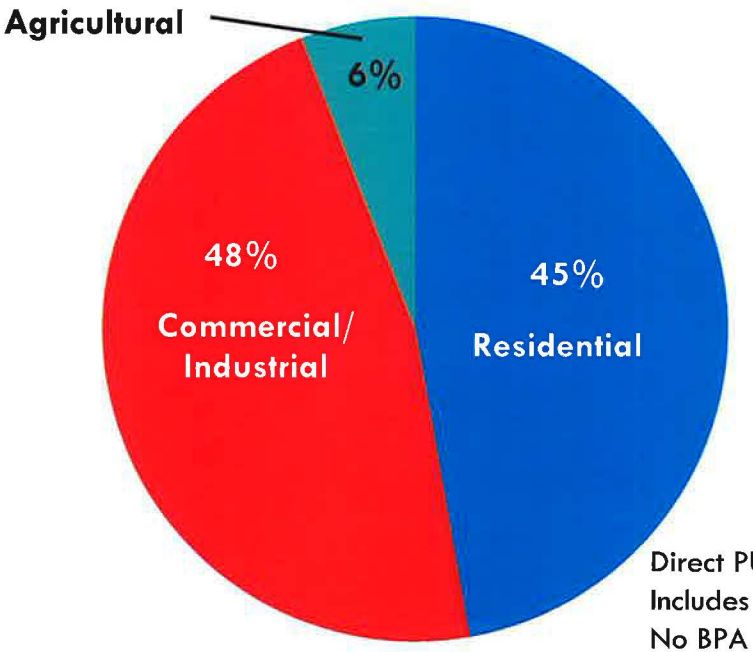
Historical Monthly Customer Field Visits



Total Field Visits 1,518

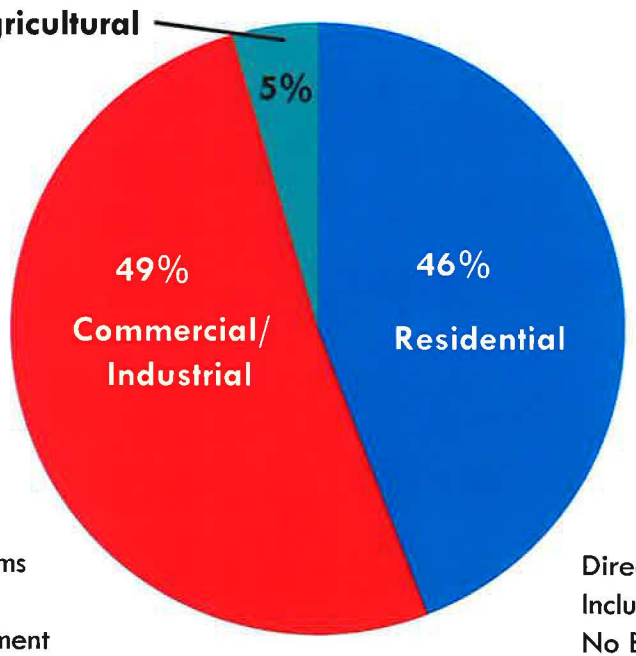
2016-2017 Conservation Statistics

2016-17 Actual Gross Spending by Sector



Direct PUD Programs
Includes Labor
No BPA reimbursement

2016-17 Actual Savings by Sector



Direct PUD Programs
Includes Labor
No BPA reimbursement

What's changed?

- New 2018-2019 Target
  - Previous target = 1.97 aMW
  - New target = 2.25 aMW
  - Increased 15%

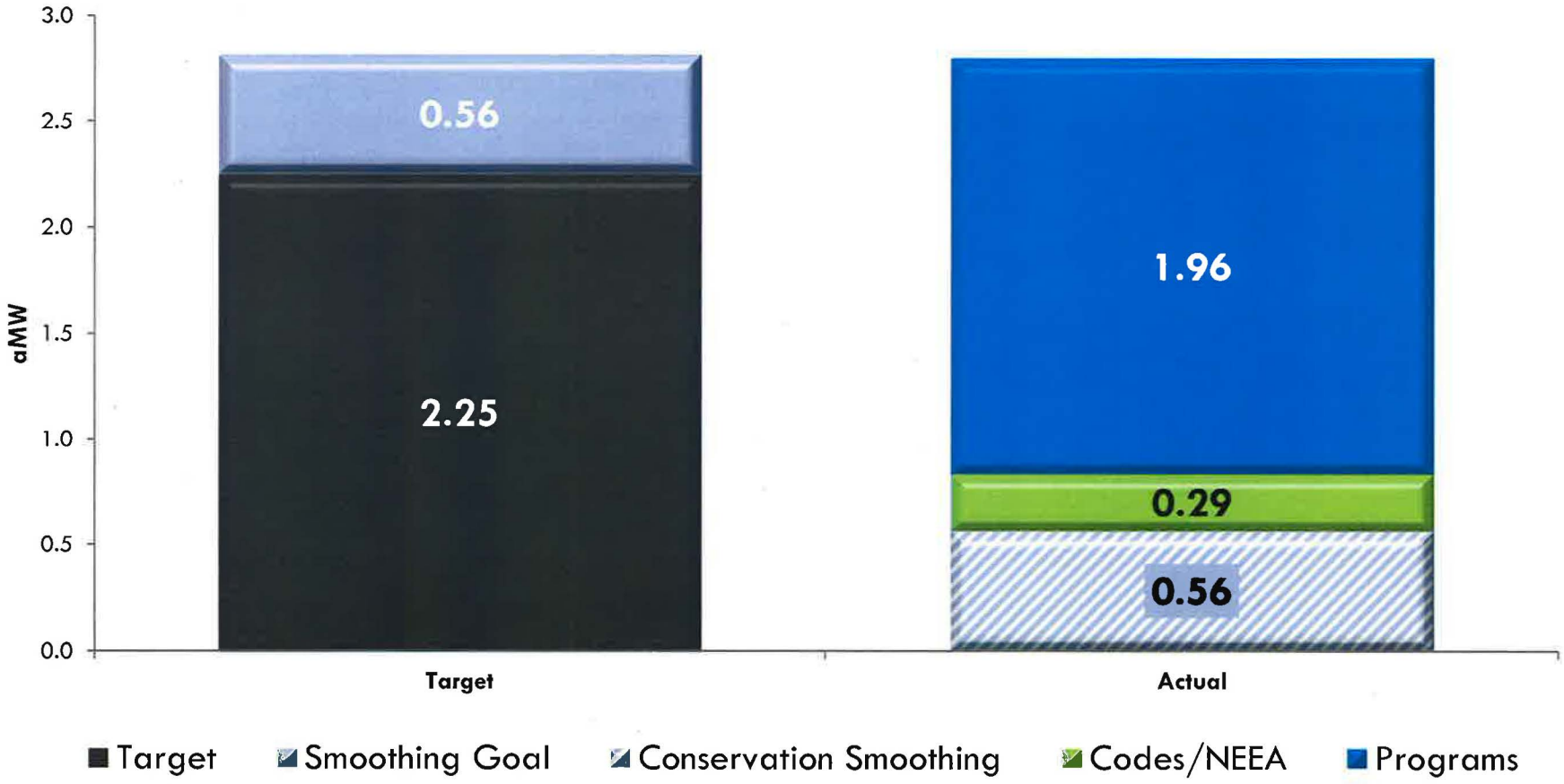
- New BPA rate period began Oct 2017
  - Previous EEI funding = $4.2M
  - New EEI funding = $4.0M
  - Decreased 5%

BONNEVILLE POWER ADMINISTRATION

- Conservation Costs Rising
  - Fixed costs rising
  - Remaining conservation more costly

BENTON P·U·D

2018-2019 Biennial Target



2018-2019 Budget Plan

	2018		2019		Total	
	($) Thousands	aMW	($) Thousands	aMW	($) Thousands	aMW
Total Residential	$ 871	0.42	$ 621	0.16	$ 1,492	0.58
Total Commercial	$ 500	0.34	$ 300	0.20	$ 800	0.54
Total Industrial	$ 700	0.35	$ 580	0.30	$ 1,280	0.65
Total Agricultural	$ 275	0.07	$ 100	0.06	$ 375	0.13
Non Federally Funded	$ 100	0.06	$ -	0.00	$ 100	0.06
Rebate Costs	$ 2,446	1.24	$ 1,601	0.72	$ 4,047	1.96
Labor & Benefits	$ 557		$ 557		$ 1,114	
Misc Dept Expenses	$ 64		$ 94		$ 158	
Total Program Costs	**$ 3,067**		**$ 2,252**		**$ 5,319**	
Reimbursement - Rebates	$ (2,471)		$ (1,101)		$ (3,572)	
Reimbursement - Perf Payment	$ (433)		$ -		$ (433)	
PTCS Reimbursement	$ (26)		$ (26)		$ (52)	
Total Reimbursement	**$ (2,930)**		**$ (1,127)**		**$ (4,057)**	
Self Funding Liability	**$ 137**	**1.24**	**$ 1,125**	**0.72**	**$ 1,263**	**1.96**

BENTON P·U·D

Conservation Policy – Resolution 2312

MARCH 24, 2015

**A RESOLUTION OF THE COMMISSION OF
PUBLIC UTILITY DISTRICT NO. 1 OF BENTON COUNTY
ADOPTING THE DISTRICT CONSERVATION REBATE POLICY**

WHEREAS, Resolution No. 2048 was passed on September 8, 2009 authorizing establishment of an Energy Conservation Plan; AND

WHEREAS, The General Manager is authorized to enter into Bonneville Power Administration's Conservation Programs and other District determined programs financially beneficial to our service area as a means to achieve energy savings; AND

WHEREAS, Washington State Energy Independence Act (EIA), RCW 19.285 (Initiative 937) mandates that each qualifying utility pursue all available conservation that is cost-effective, reliable and feasible; AND

WHEREAS, District Commissioners set a biennial target every two years to meet the requirements of the EIA; AND

WHEREAS, District staff establish biennial conservation budgets to assure the targets are met; AND

WHEREAS, Conservation program offerings are managed to meet the biennial budget and funding may not be adequate to provide rebates for all customer requests; AND

WHEREAS, The District wishes to outline the policy by which it will provide conservation rebates in an equitable manner.

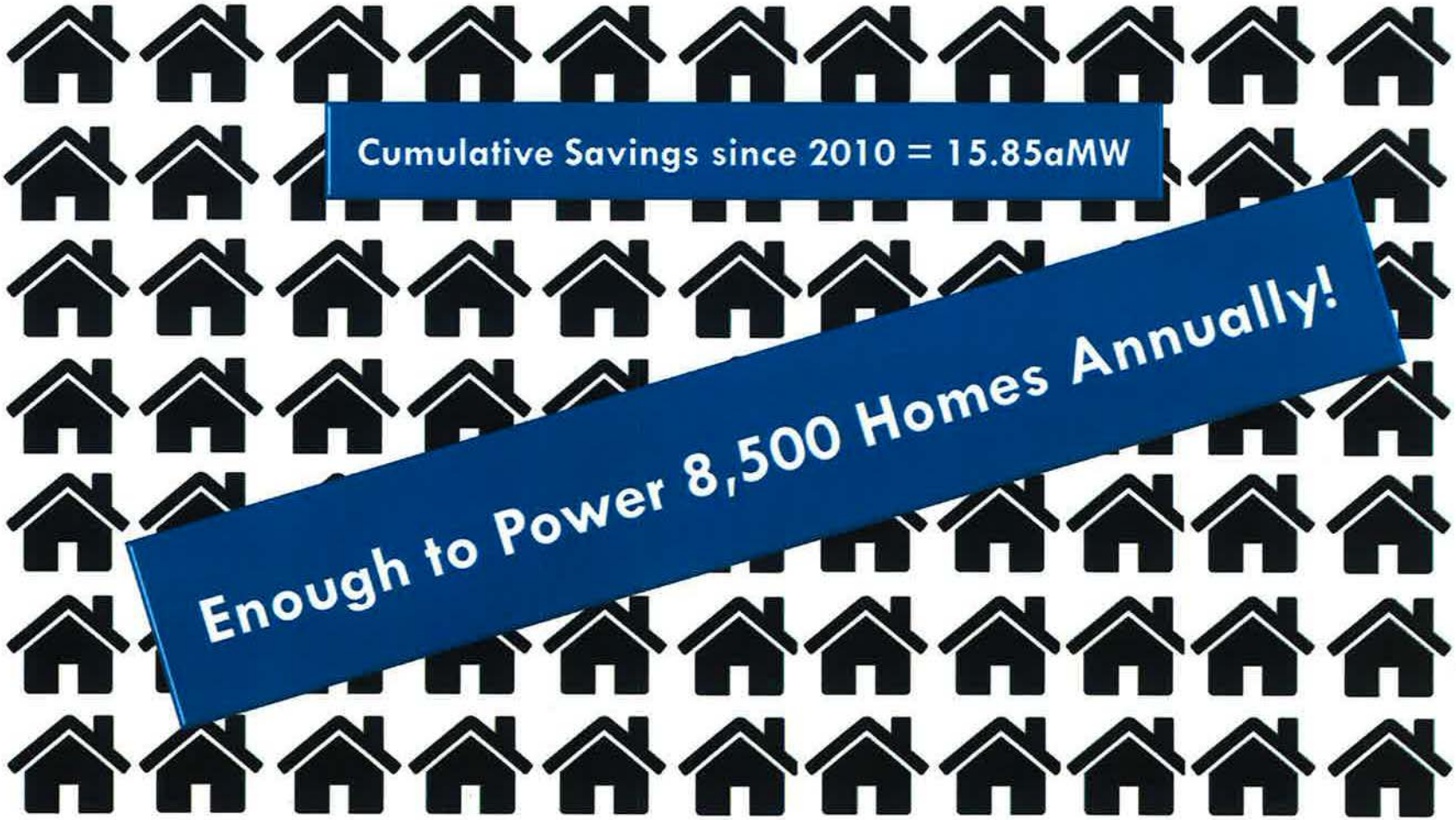
Summary

- Trusted Energy Partner
- Satisfy EIA requirements
- Higher targets & reduced BPA funds
- Budget aligns with District Conservation Policy
- Monitor internal/external program costs & savings
- Meet & exceed conservation targets

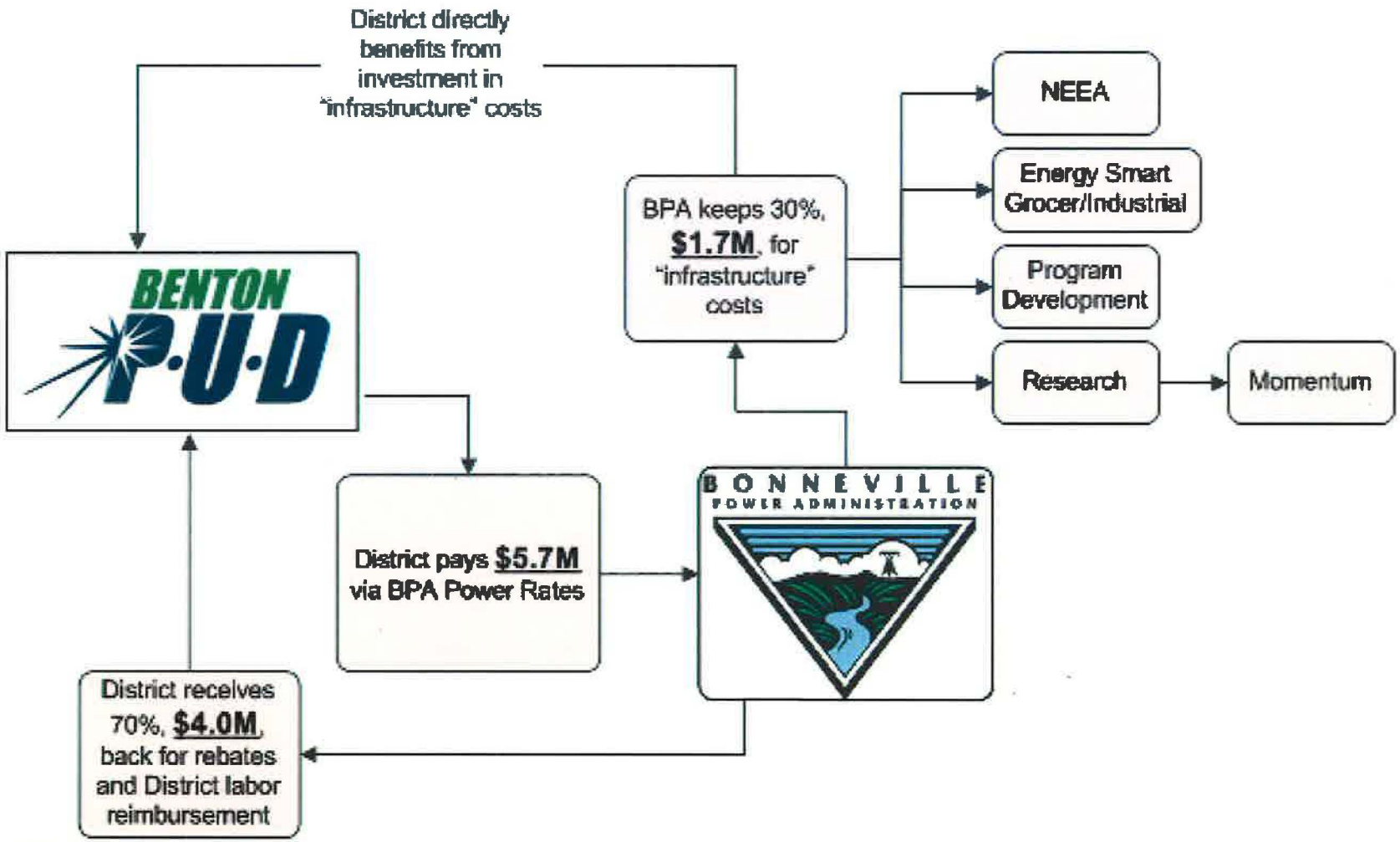
Questions

2018-2019 Budget Increase

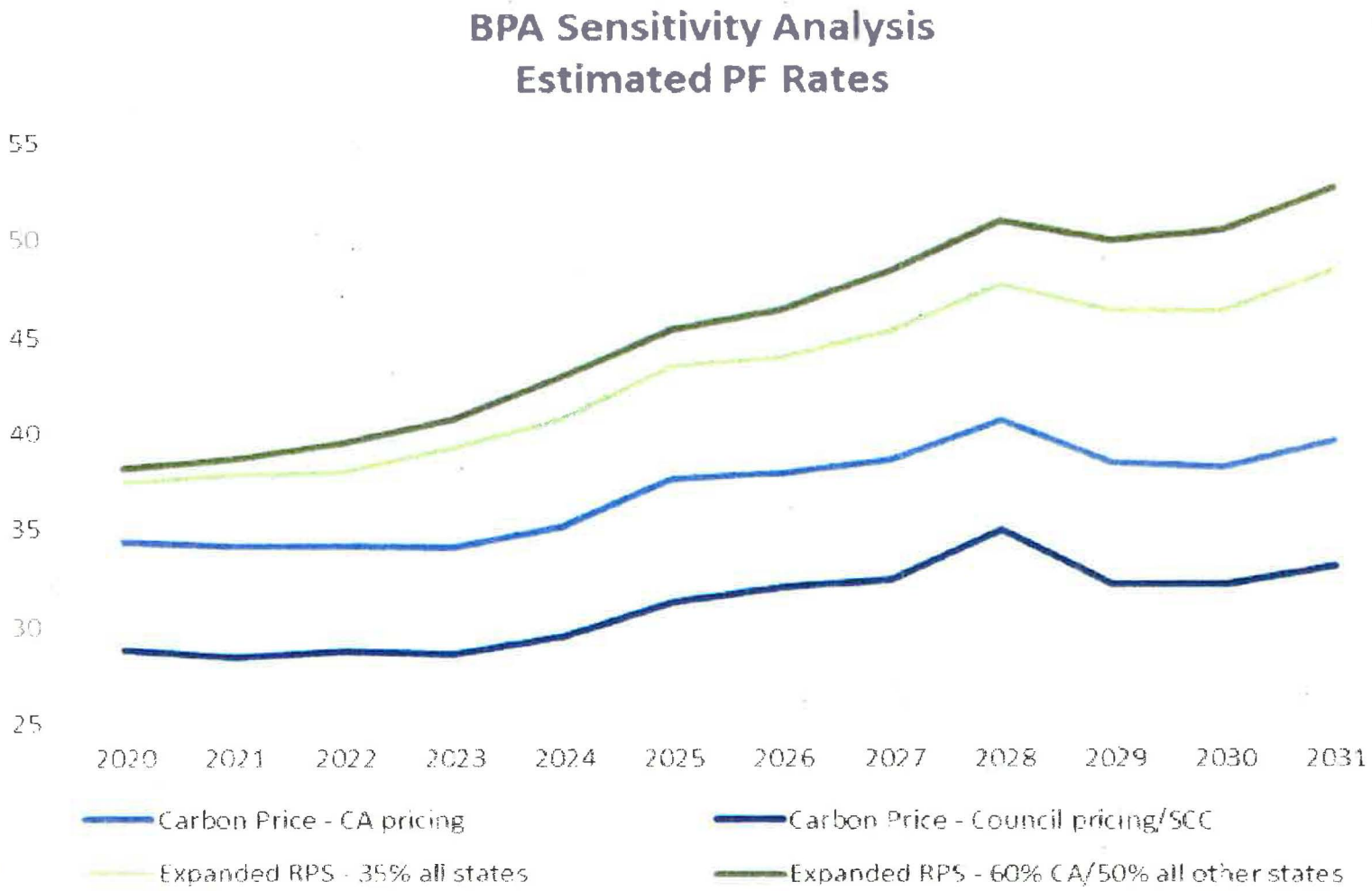
Historical Targets Vs Actual Saving



Conservation Cash FLow



IMPACT TO BPA RATES



Source: BPA Sensitivity Analysis 3/16/2017

KEY TAKE-AWAYS

- Carbon policies in all Western states have an impact on the market and all utilities.
- Current Renewable Portfolio Standards are not the most cost-effective way to reduce carbon.
- Policies don't currently recognize the carbon-free attributes of existing resources, reducing their value and contributing to oversupply.
- Oversupply of energy in the WECC is creating low and negative market prices that will continue.

E3 NW Low Carbon Scenario Analysis - Talking Points

- In late 2016, Chelan County PUD commissioned Energy and Environmental Economics, Inc., (E3), an internationally prominent consulting firm in electricity economics, to conduct a literature review to develop a cross-sector supply curve for emission reductions measures in the Northwest. This work highlighted the need to develop a methodology that could evaluate options for achieving carbon emissions goals while also maintaining a least-cost approach to meeting electric power demand.

- If the Western states are to further evolve policies to achieve carbon emissions reduction goals, PGP believes it is important for efforts to be informed by an understanding of which alternatives are least cost and most effective in achieving substantial reductions from 1990 levels.

- For that reason, PGP commissioned E3 to develop a NW version of a commonly used tool for electric sector scenario analysis (RESOLVE) to evaluate what policies best support a least-cost approach to carbon emissions and what that means for the Northwest resource portfolio.

- The E3 economic model optimizes both economic dispatch and investment decisions over time. It selects an optimal portfolio of renewable, conventional and demand-side resources to meet electric loads reliably while complying with policy targets for renewables and greenhouse gases. The model is specifically designed to simulate electricity systems under high renewable penetration. The methodology is designed to be flexible enough to adapt as technologies, markets, and regulations change.

- The project sponsors are still reviewing the key findings but wanted to make them more broadly available because we believe this study provides detailed analysis useful to policy makers. The study scenarios found the following:

  - To achieve long-term carbon emissions reduction goals most cost-effectively, the Northwest will need to maintain existing carbon-free resources and energy efficiency investments and transition from coal to the least-cost combination of renewable resources, natural gas and other technologies to meet energy and capacity needs.

  - Policies that target carbon directly, like a carbon tax or a cap-and-trade program, achieve the most reductions – and at a lower cost - than an increased Renewable Portfolio Standard (RPS).

  - Although renewable resources are an integral part of the solution in meeting long-term carbon emissions reduction goals, mandating a higher RPS requirement is an expensive way to achieve the goal because an increase in renewable resources alone is not the most cost-effective near-term solution and it does not provide an economic signal for increased energy efficiency investments or maintenance and reinvestment in existing carbon-free resources.

  - The E3 study found that displacing coal with natural gas (which has less than half the emissions of coal per MWh) and some amount of renewable resources is the most cost-effective, near-term carbon emissions reduction option.

- Energy efficiency will continue to play a key role and additional work is needed to identify the next generation of energy efficiency measures.

- The Northwest's historical carbon-free power resources (including hydropower, nuclear and energy efficiency) provide a significant benefit under a policy that targets carbon emissions reduction directly and does not discriminate among non-emitting resources.

- Electrification of transportation appears to be a low-cost strategy for emissions reduction. To fully realize those benefits, cross-sector considerations of funding and analysis are needed. For example, transportation electrification costs are borne in the electric sector but the benefits are realized in the transportation sector.

- The project sponsors will be looking closely at the study, sharing it with other utilities, stakeholders, policy makers, and the public. The project sponsors hope it will help start a dialogue and provide technical support for those making decisions about policies that intersect environmental and energy issues in Washington and Oregon. Ultimately, the projects sponsors are interested in exploring methods that can evaluate the least-cost, highest effectiveness approach to carbon emissions reduction across all sectors.

	Emission Reductions*	Cost per year*	Average cost per metric ton	Ability to reach State's GHG objectives
Carbon Cap - 80% below 1990	21 MMt	$1.1B	$50	Yes
~~Carbon Tax~~	~~19 MMt~~	~~$0.8B~~	~~$42~~	~~Possible, if~~ increased
RPS – 50%	12 MMt	$2.1B	$187	No
No New Gas	2 MMt	$1.2B	$592	No

* relative to the Reference Case based on current policy

Frequently Asked Questions

- **Who are the Study Sponsors?**

The Sponsors are the ten utilities that are members of the Public Generating Pool (PGP) [*Chelan County PUD, Clark County PUD, Cowlitz County PUD, Eugene Water and Electric Board, Grant County PUD, Klickitat County PUD, Lewis County PUD, Pend Oreille County PUD, Snohomish County PUD, Tacoma Power*], Benton County PUD and Energy Northwest.

- **Who is E3?**

Energy and Environmental Economics, Inc. (E3) is an internationally prominent consulting firm in electricity economics that is based in San Francisco, California. E3 has substantial experience modeling electricity system operations and investment under aggressive policy goals. E3 has worked with many Pacific Northwest utilities since its founding in 1989 and has a comprehensive understanding of the unique nature of the Northwest's hydro-dominated electricity system.

- **Why did the Sponsors commission this study?**

If the Western states are to further evolve policies to achieve carbon emissions goals, the Sponsors believe it is important for efforts to be informed by an understanding of which alternatives are least cost and most effective in achieving substantial reductions from 1990 levels. We are seeking to advance an approach to better define cost-effective options for achieving carbon emissions goals within the electric sector while also maintaining a least-cost approach to meeting electric power demand.

This is a relatively new body of work and we feel strongly that analyzing least-cost approaches is critical to sound public policy-making. We intend to use the study to inform our positions on emerging public policy. We are, however, particularly committed to working collaboratively with others to refine the methodology so that an adaptable regulatory framework can be developed to guide policy for years to come. We are also interested in applying this approach in a multi-sector manner.

- **What type of scenarios did the study consider?**

The study considered scenarios for electricity sector clean energy policy: a base case reflecting current state policy and industry trends; several cases imposing increased RPS targets on WA & OR (30%, 40% or 50%); a carbon cap scenario (40%, 60% and of 80% below 1990 levels); a scenario with an escalating carbon tax ($15 in 2020 and $25 in 2020) on the electric sector; and a scenario where new natural gas generation is prohibited.

- **Which computer model was used for the study?**

The study used the Renewable Energy Solutions Model, also known as RESOLVE. RESOLVE is an open-source electricity system planning model developed by E3 that has been specifically designed to simulate electricity systems operations and investments

under high renewable penetration. RESOLVE has been used to study aggressive renewables and greenhouse gas goals in multiple jurisdictions including California, Hawaii, New York and South Africa.

- **How does the model work?**

RESOLVE selects least-cost portfolios of renewable and conventional electricity resources over the 2020-2050 time period for Washington, Oregon, Northern Idaho and Western Montana. The model considers the fixed costs of new resources and the variable costs, output profiles, operating characteristics and carbon emissions of both existing and new resources and identifies an optimal combination that meets energy and grid reliability needs while complying with various policy targets. The methodology is designed to be flexible enough to adapt as technologies, markets, and regulations change over time.

- **What does the study conclude about the cost of reducing carbon emissions by regulating carbon through a carbon price or regulation?**

The study shows that regulating emissions through a carbon price or emission cap is the least-cost and most effective way to achieve carbon emissions reduction. Specifically, the carbon cap scenario is the only scenario that achieves the desired goal by the target date (2050) and at a much lower cost to the public than other policies.

The model projects that 40% – 60% reductions below 1990 levels can be met in large part by displacing coal with a least-cost combination of cost-effective energy efficiency, demand response, renewable resources, and natural gas generation. More significant reductions (80% below 1990 levels) in later years will require increased investments in renewable generation, higher-cost energy efficiency choices, and other technologies.

- **Is a carbon price or regulation needed if the coal plants are retired early?**

Economics and other interests may result in coal plants being retired earlier than identified in this analysis. However, a carbon price or regulation ensures that the plants are retired on a timely basis to meet emissions goals and ensures a least-cost solution in replacing coal plants. Carbon specific regulation also provides proper price signals for the value of energy efficiency and existing carbon-free resources. Finally, a multi-sector carbon policy provides the structure for least-cost carbon emissions solutions across the economy.

- **What does the study conclude about the effectiveness of a Renewables Portfolio Standard (RPS) at meeting carbon reduction goals?**

While renewable generation is an important component of a low-carbon future, a higher RPS results in higher costs and higher carbon emissions than a policy that focuses directly on carbon. This is because an RPS ignores other measures such as energy efficiency and coal retirement that can reduce carbon emissions at lower cost. An RPS also has unintended consequences such as oversupply and negative wholesale electricity prices that create challenges for reinvestment in existing zero-carbon resources.

While RPS policy has been successful in the past at driving investment in renewables and spurring technology improvement, achieving deep carbon reductions requires policies that are more comprehensive. Specifically, the carbon cap scenario is the only scenario that achieves the desired goal by the target date (2050) and at a much lower cost to the public than other policies.

- **If a higher RPS is not the most cost-effective, does that mean that new renewables aren't needed?**

No. In fact, the model relies on approximately 5,000 MW of renewables still required under existing RPS policies and indicates that another 6,000 MW of new renewables is needed to meet the goal of 80% emissions below 1990 levels. Further, a transportation electrification scenario with 3.5 million additional electric vehicles by 2050 requires 5,000 MW of new renewable resources and other technologies, and could be higher depending on the increased demand for electricity.

- **What does the study conclude about nuclear, hydropower, and energy efficiency?**

Existing zero-emitting resources are shown to provide a significant benefit in avoiding carbon emissions. Retirement of 2000 aMW of nuclear and hydropower resources results in 5 million tons of additional carbon emissions, unless they are replaced with other zero carbon resources. Avoiding these additional carbon emissions while maintaining reliable electricity service requires the development of 5500 MW of new renewable generation and 2000 MW of new natural gas capacity, at an annual cost of $1.6 billion.

- **Does the study identify any pathways for mitigating the impact of carbon emissions reductions on electric customers?**

Yes, the study assumes that revenues collected from electricity ratepayers under a policy that places a price on carbon, such as cap-and-trade or carbon tax, are returned to the electricity sector. This ensures that electricity ratepayers are not required to pay twice: once for the cost of investments in zero-carbon resources, and second for emissions that remain in the electricity sector. Directing the revenues to another purpose could increase the cost to electricity ratepayers by as much as $1 billion per year, resulting in a transfer of wealth from ratepayers to other segments of society that is not needed to achieve carbon goals.

- **What does the study conclude about natural gas generation?**

The study concludes that new natural gas generation is part of a least-cost portfolio for serving electric load even under carbon-constrained scenarios. Prohibiting the construction of new natural gas generation raises electricity costs by over $1 billion per year while doing very little to avoid additional carbon emissions. Moreover, more study is needed to determine whether a system without new gas generation can meet electricity system reliability requirements.

- **Did the study consider transportation and building electrification?**

Yes, the study found that vehicle electrification can offer a low-cost source of carbon mitigation (if vehicles are powered by non-emitting resources) compared to requiring reductions only in the electric sector. While there are societal benefits to the vehicle electrification, there are costs to the electric sector. The sponsors suggest that more work be done to address cross-sector considerations for funding and analysis.

- **How were energy efficiency and demand response considered in the study?**

The study incorporates energy efficiency that was found to be cost-effective in the Northwest Power and Conservation Council's 7th Power Plan into all scenarios. Additional energy efficiency and demand response resources are selected as part of the least-cost portfolio for most scenarios.

- **How was distributed generation assumed in the model?**

Some amount of Distributed Generation (DG) is assumed to be incorporated into the load forecast. DG is not modeled explicitly as a supply resource. The study results would not change meaningfully even if a significant quantity of DG were made available. DG wind or solar would substitute directly for grid-scale wind or solar, with small differences in cost and performance.

- **Would the inclusion of Canadian resources have changed the results of this study?**

The model did not include the Canadian electricity system due to data limitations. Canada does have significant storage capability; however, the benefits would be limited by existing transmission capability, which is estimated to be 2,000 MW. Inclusion of Canada would not have changed the relative outcomes of this study.

- **What time period was considered?**

The study utilized the Northwest RESOLVE model to minimize the sum of investment and operating costs on a net present value (NPV) basis over a 30-year time period from 2020-2050. Single year snapshots of results have been pulled out to help make the model results more intuitive and easier to understand.

- **Does the study inform us on the jobs impacts? Do any of the scenarios create and/or destroy jobs?**

The study does not consider jobs or macroeconomic impacts. Investments in new infrastructure typically result in an increase in construction jobs and gross domestic product in the near-term due to economic stimulus, and a reduction in economy-wide jobs and gross domestic product over time due to higher electric rates as the investments are paid off.

- **Did the study consider RPS levels above 50%?**

The RPS policy reaches a point of diminishing returns at levels above 30%. The Northwest electricity system is served with approximately 70% carbon-free generation today, and already has a surplus of zero-carbon hydroelectric and wind energy during some times of the year. As new renewable resources are added, increasing quantities of energy are either exported or mandatorily reduced (curtailed). When the RPS is increased from 40% to 50%, approximately 2/3 of the output from renewable resources selected to comply with the 50% RPS are either curtailed or exported. Under the 50% RPS scenario, zero carbon generation is sufficient to meet 121% of electricity sales over the course of a year.

- **Do any of the scenarios inhibit or promote the adoption of emerging technologies like electric vehicles (EVs) or battery storage?**

Policy that focuses exclusively on renewables will promote advancement of renewable technologies, but will do little to foster advancement of other technologies such as EVs. Policy that focuses on greenhouse gas emissions across the entire economy would have the best chance of fostering broad-based technological innovation.

- **Do any of the scenarios provide "link to" or "provide coordination with" other carbon policies?**

A cap-and-trade policy for carbon emissions could be linked to existing programs such as the California-Quebec-Ontario trading system or the Regional Greenhouse Gas Initiative (RGGI) system. Cap-and-trade and/or tax policies also provide a price signal for carbon emissions in the transportation, building and industry sectors, which helps to provide consumers and businesses with a signal to make investments to help reduce their carbon emissions, such as vehicle or building electrification. RPS policies, on the other hand, tend to hinder cross-state trading as individual states typically have different definitions of qualifying renewable energy facilities and do not promote other reduction measures due to their narrow focus on renewable electricity supply.

- **Is there a difference in how the policies affect wholesale electricity markets?**

Electricity ratepayers across the region have benefited from a robust wholesale electricity market. An RPS policy suppresses wholesale electricity prices and sometimes causes prices to go negative. This results in lower wholesale market revenues—and therefore higher rates—for hydro-dominated utilities such as the Bonneville Power Administration. A carbon cap or tax policy has the opposite effect.

In addition, state-specific carbon pricing systems may result in different prices on carbon for different jurisdictions within the Western Interconnection. This could have a significant impact on market liquidity and create challenges for interconnected operations.

- **Why is 80% below 1990 levels by 2050 identified as the goal?**

These goals have been identified by both Oregon and Washington as desired emissions levels. Although they are not reflected in statute, both states have introduced legislation as emissions goals. These goals have their origins in scientific work conducted under the auspices of the International Panel on Climate Change (IPCC) that explored emissions reductions needed to maintain aggregate warming at no more than 2 degrees Celsius.

- **What are the next steps for the study?**

The project sponsors will be looking closely at the study, sharing it with policy makers, other utilities and stakeholders, and the public. We hope it will help start a dialogue and provide technical support for those making decisions about policies that intersect environmental and energy issues in Washington. Ultimately, we are interested in exploring methods and approach that can evaluate across the least-cost, highest effectiveness approach to carbon emission reductions.

Benton PUD

Commission Meeting

November 14, 2017

Northwest Low Carbon

Scenario Analysis

(Selected Slides from PGP and E3 Presentations)

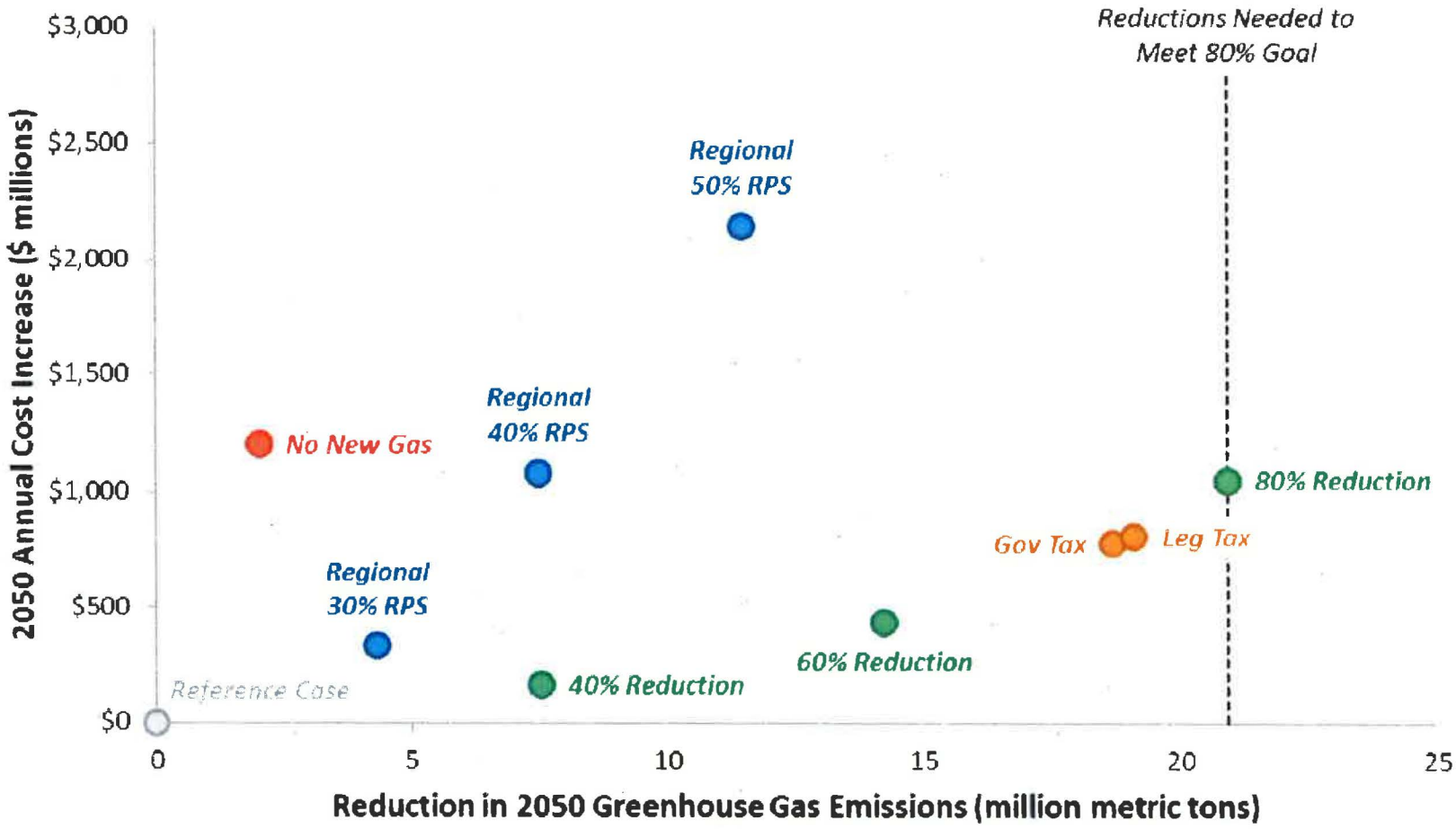
Northwest Low Carbon Scenario Analysis

Achieving Least-Cost Carbon Reduction in the Electric Sector

NOVEMBER 8, 2017

PGP
Public Generating Pool

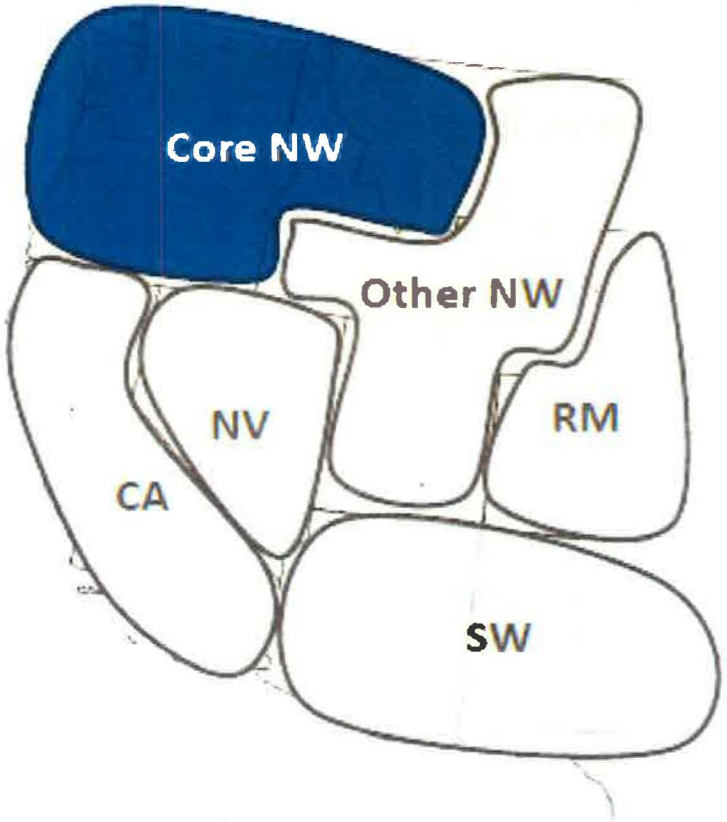
Cost & Emissions Impacts
All Cases



Note: Reference Case reflects current industry trends and state policies, including Oregon's 50% RPS goal for IOUs and Washington's 15% RPS for large utilities

Study Footprint

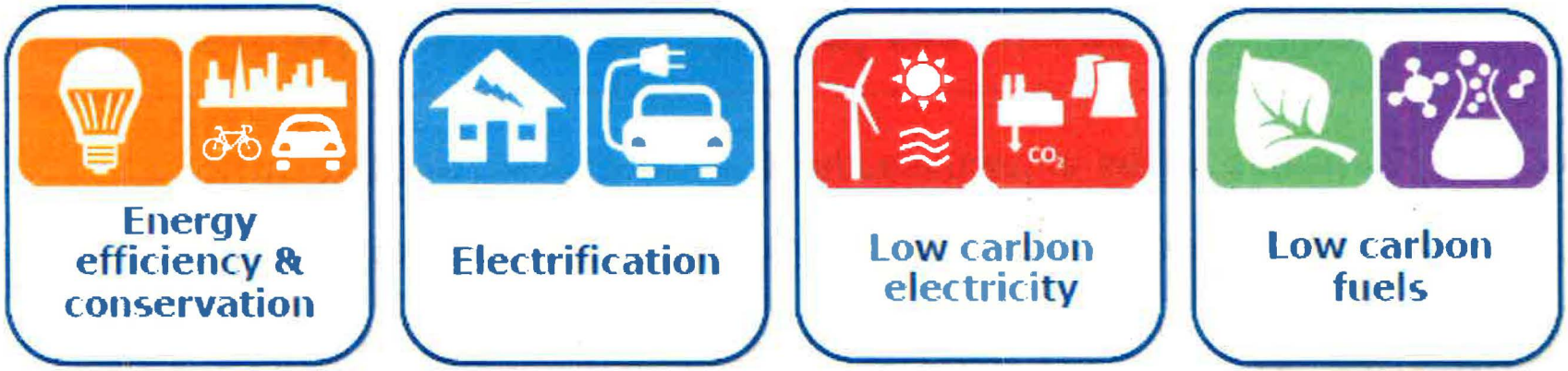
- **RESOLVE is used to optimize a portfolio for "Core NW" loads in Washington, Oregon, northern Idaho and western Montana**
- **Remaining BAs of the WECC are grouped into five zones**
  - RESOLVE optimizes operations—but not investments—in external zones to reflect market opportunities for energy trading between regions in investment decisions
- **British Columbia and Alberta are not modeled**



Overview of the Analysis

+ **This study uses E3's Renewable Energy Solutions (RESOLVE) Model to select optimal portfolio of renewable and conventional resources for each scenario**
  - RESOLVE was designed for modeling operations and investments for high-renewable power systems
  - Utilized in several jurisdictions including California, Hawaii and New York
+ **RESOLVE minimizes the sum of investment and operating costs over a defined time period**
  - Investment decisions are made every 10 years between 2020 and 2050
  - Performs optimal dispatch over a representative set of operating days in each year
+ **Selects least-cost combination of resources over time**
  - Meets energy, capacity and balancing needs
  - Complies with RPS or GHG target ("overbuilding" portfolio if necessary)

Four "Pillars" of Decarbonization to Meet Long-Term Goals

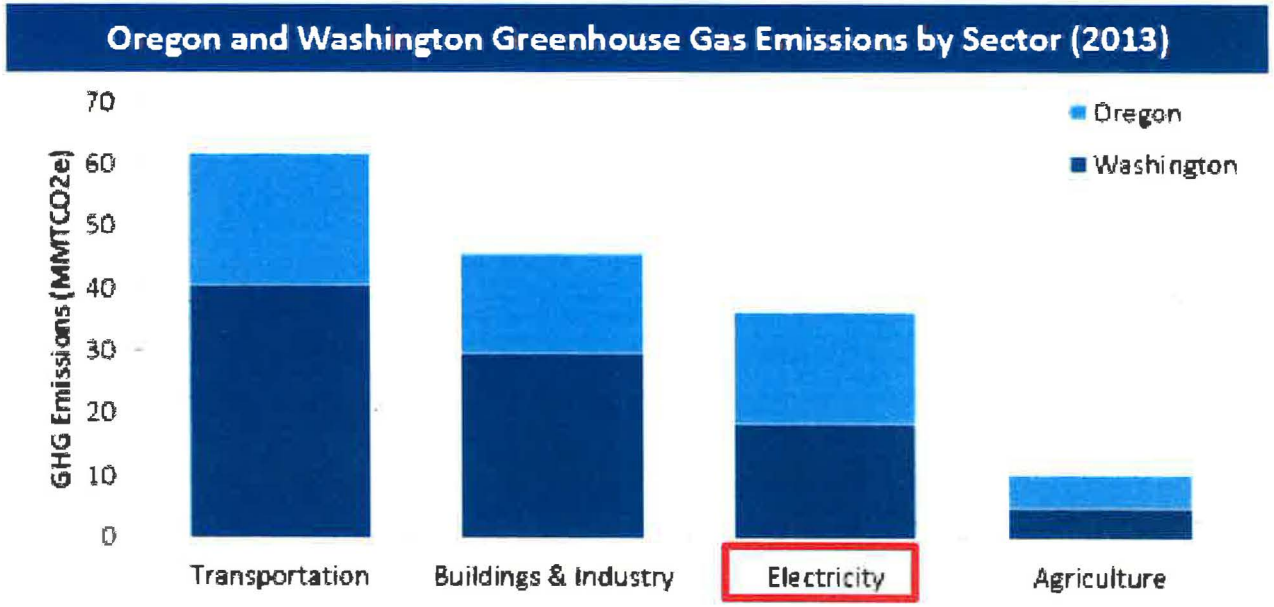


- **Four foundational elements are consistently identified in studies of strategies to meet deep decarbonization goals**
- **Across most decarbonization studies, electric sector plays a central role in meeting goals**
  - Through direct carbon reductions
  - Through electrification of loads to reduce emissions in other sectors

Meeting Long-Term GHG Goals Requires Reductions from All Sectors

+ **Largest sources of GHG emissions in the region guide prioritization of emission reduction strategies:**

1. Transportation
2. Buildings and industry
3. Electricity



Sources: Report to the Legislature on Washington Greenhouse Gas Emissions Inventory: 2010 – 2013 (*link*); Oregon Greenhouse Gas In-boundary Inventory (*link*)

Overview of Core Policy Scenarios

1. **Reference Case:** reflects current state policy and industry trends
2. **Carbon Cap Cases:** meet electric sector reduction goal through implementation of a carbon cap on the electric sector
   - **40%, 60%,** and **80%** GHG reduction by 2050
3. **Carbon Tax Cases:** impose an escalating carbon tax on the electric sector
   - **WA Leg. tax proposal** ($15/ton in 2020 escalating at 5.5%/yr. + inflation)
   - **WA Gov. tax proposal** ($25/ton in 2020 escalating at 3.0%/yr. + inflation)
4. **High RPS Cases:** impose increased RPS targets upon WA & OR utilities by 2050 as a policy mechanism to decarbonize the electric sector
   - **30%, 40%,** and **50%** RPS achieved regionally by 2050
5. **'No New Gas' Case:** prohibits construction of new gas generation

2050 Scenario Summary

Scenario	Inc Cost ($MM/yr.)	GHG Reductions (MMT)	Avg GHG Abatement Cost ($/ton)	Effective RPS %	Zero Carbon %	Renewable Curtailment (aMW)
Reference	—	—	—	20%	91%	201
40% Reduction	+$163	7.5	$22	21%	92%	294
60% Reduction	+$434	14.2	$30	25%	95%	364
80% Reduction	+$1,046	20.9	$50	31%	102%	546
30% RPS	+$330	4.3	$77	30%	101%	313
40% RPS	+$1,077	7.5	$144	40%	111%	580
50% RPS	+$2,146	11.5	$187	50%	121%	1,033
Leg Tax ($15-75)	+$804	19.1	$42	28%	99%	437
Gov Tax ($25-61)	+$775	18.7	$41	28%	99%	424
No New Gas	+$1,202	2.0	$592	22%	93%	337

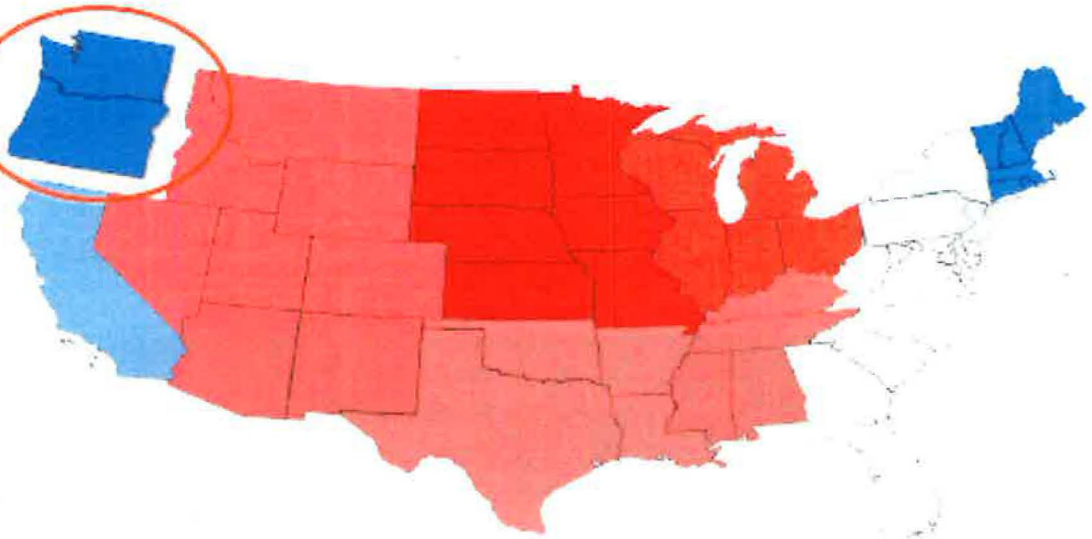
Incremental cost and GHG reductions are measured relative to the Reference Case

Carbon Intensity of the Northwest's Electricity Sector is Relatively Low

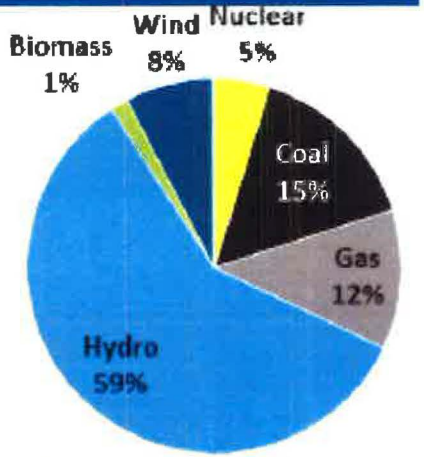
+ Due to large fleet of existing zero-carbon resources, electric emissions intensity in the Pacific Northwest is already below other regions in the United States

2013 Regional GHG Intensity of Electricity Supply (tons/MWh)

2013 emissions intensity:
0.26 tons/MWh
(includes out-of-state coal resources)



WA/OR Generation Mix



Energy+Environmental Economics

Figure developed using data gathered from state 2013 GHG inventories for Washington, Oregon, and California; supplemented with data from EIA Annual Energy Outlook 2016

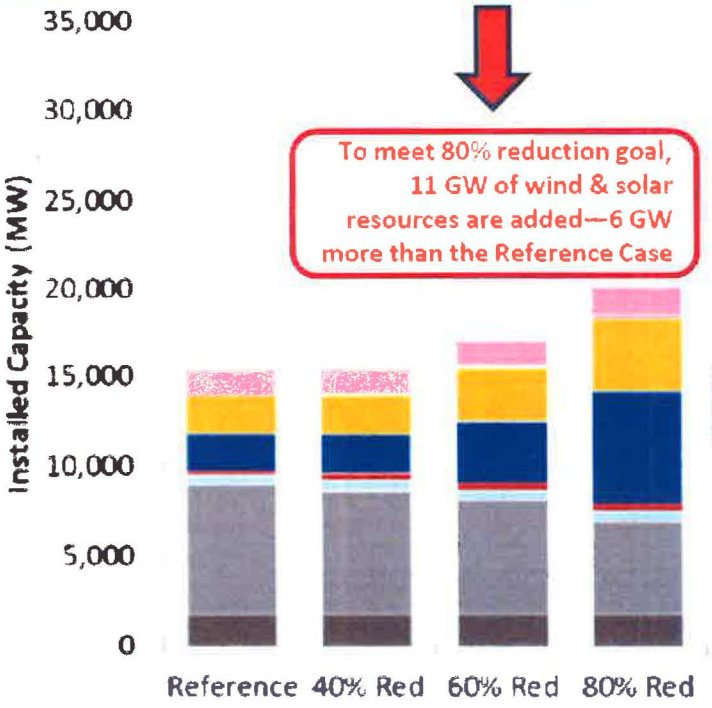
2050 Portfolio Summary
Carbon Cap Scenarios

Highlights

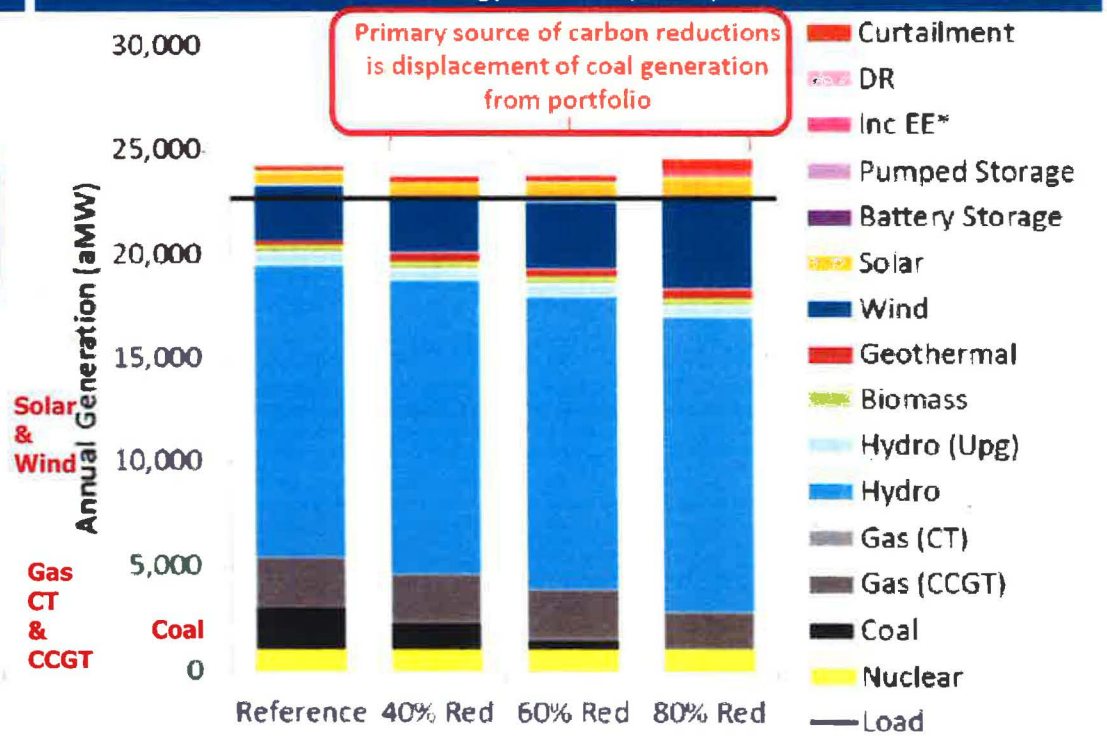
- Coal retired under 80% Case, replaced with renewables & gas
- 11 GW of new renewables by 2050
- 7 GW of new gas capacity added
- Gas capacity factor is 30% in 2050

Scenario	Inc Cost ($MM/yr.)	GHG Reductions (MMT)	Effective RPS %	Zero CO2 %
Reference	—	—	20%	91%
40% Reduction	+$163	7.5	21%	92%
60% Reduction	+$434	14.2	25%	95%
80% Reduction	+$1,046	20.9	31%	102%

Resources Added (MW)



Energy Balance (aMW)



* EE shown here is incremental to efficiency included in load forecast (based on NWPCC 7th Plan)

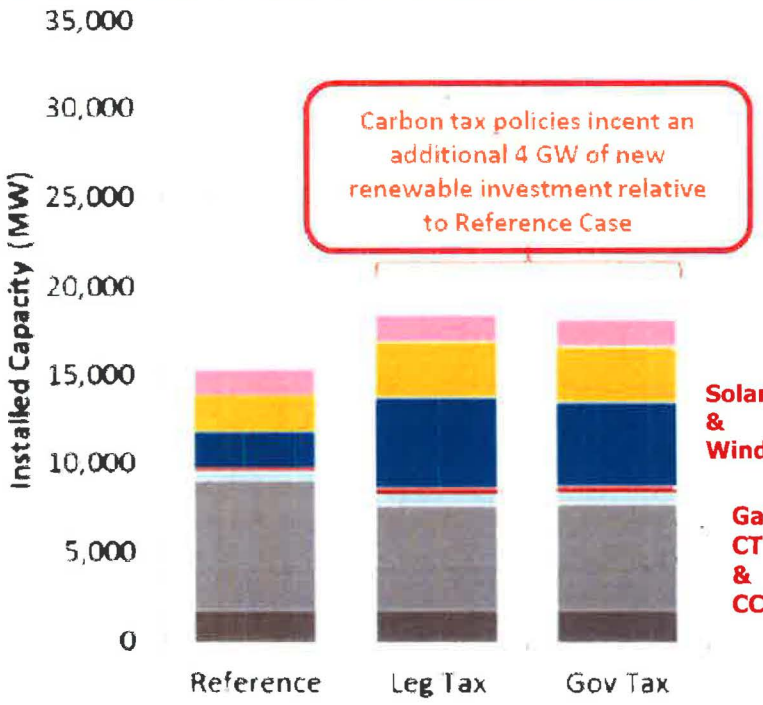
2050 Portfolio Summary
Carbon Tax Scenarios

Highlights

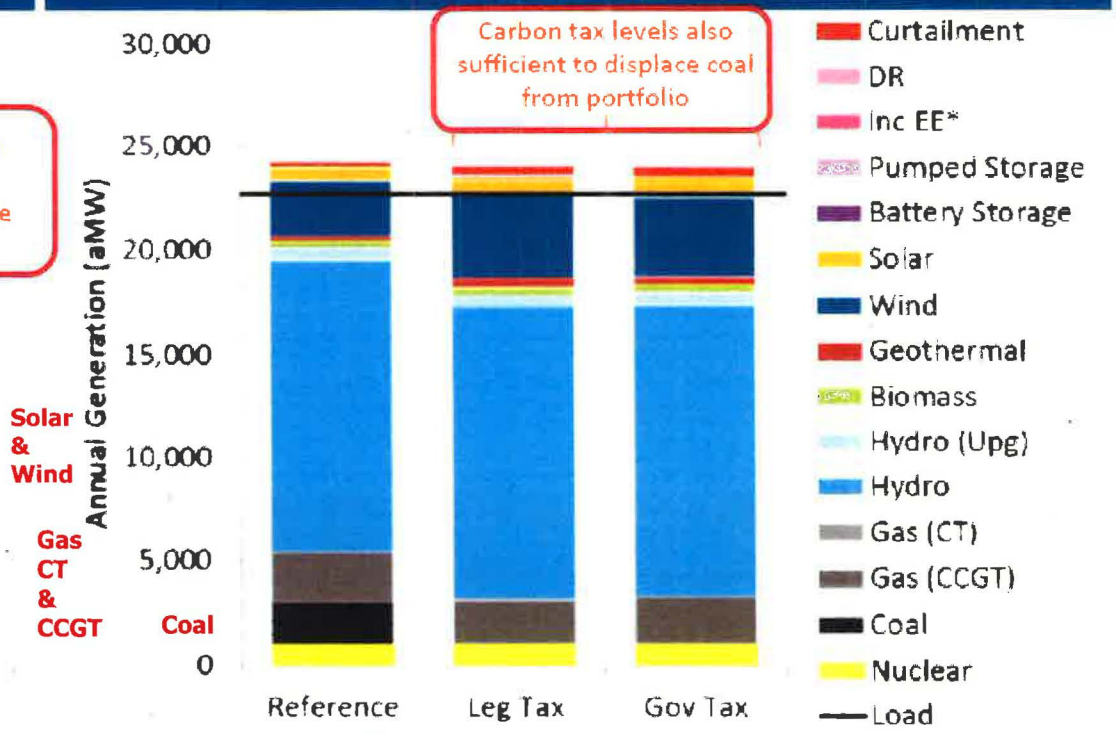
- Coal retired under both cases and replaced with renewables & gas
- 9 GW of new renewables needed
- Carbon tax and cap lead to similar outcomes with these resource costs

Scenario	Inc Cost ($MM/yr.)	GHG Reductions (MMT)	Effective RPS %	Zero CO2 %
Reference	—	—	20%	91%
Leg Tax ($15-75)	+$804	19.1	28%	99%
Gov Tax ($25-61)	+$775	18.7	28%	99%

Resources Added (MW)

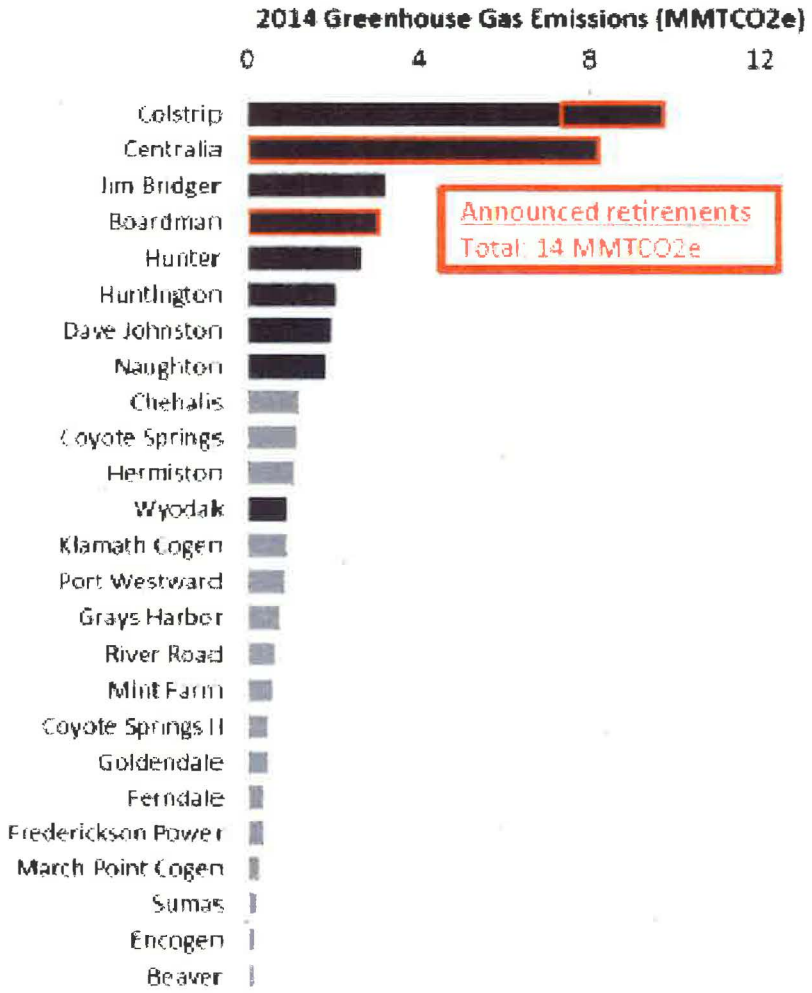


Energy Balance (aMW)



* EE shown here is incremental to efficiency included in load forecast (based on NWPCC 7th Plan)

A Handful of Plants are Responsible for Most of the Electric Sector GHG Emissions in the Northwest



+ **Existing coal plants (9 units) are responsible for 33 million metric tons of emissions—roughly 80% of all emissions attributed to Washington & Oregon**
  - Includes contracted generation in Montana, Wyoming
+ **Existing gas generation accounts for roughly 9 million metric tons**

Carbon Tax vs. Cap-and-Trade: Qualitative Factors

Resource Option	Carbon Tax	Carbon Cap-and-Trade
Compliance mechanism	Pay tax on each ton of CO2 emissions	Surrender carbon allowance for each ton of CO2 emissions
Disposition of funds collected	Tax revenue appropriated through legislative process	Allowances can be auctioned or allocated to affected companies; auction revenues administered by state agency (e.g., DEQ)
Breadth of carbon abatement options	In-state abatement options only	Ability to link with regional carbon markets to expand liquidity
Effect on electric markets	Potential for multiple prices on carbon within Western Interconnection creates challenges for market liquidity and interconnected operations	Single regional price on carbon would preserve wholesale power market liquidity and avoid operational wrinkles
Emissions reductions	Carbon price is fixed but actual emissions levels would vary	Emissions levels are specified, but carbon price would vary over time as abatement costs change

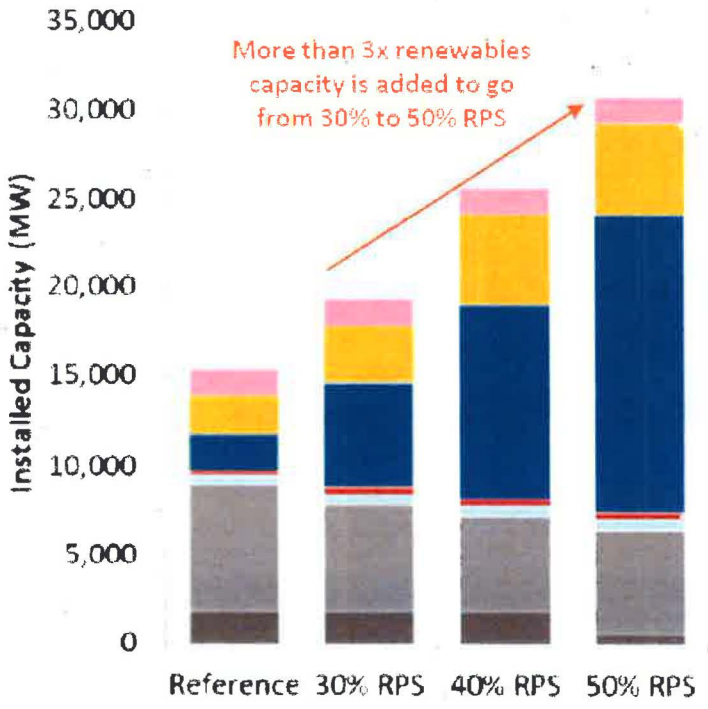
2050 Portfolio Summary
High RPS Scenarios

Highlights

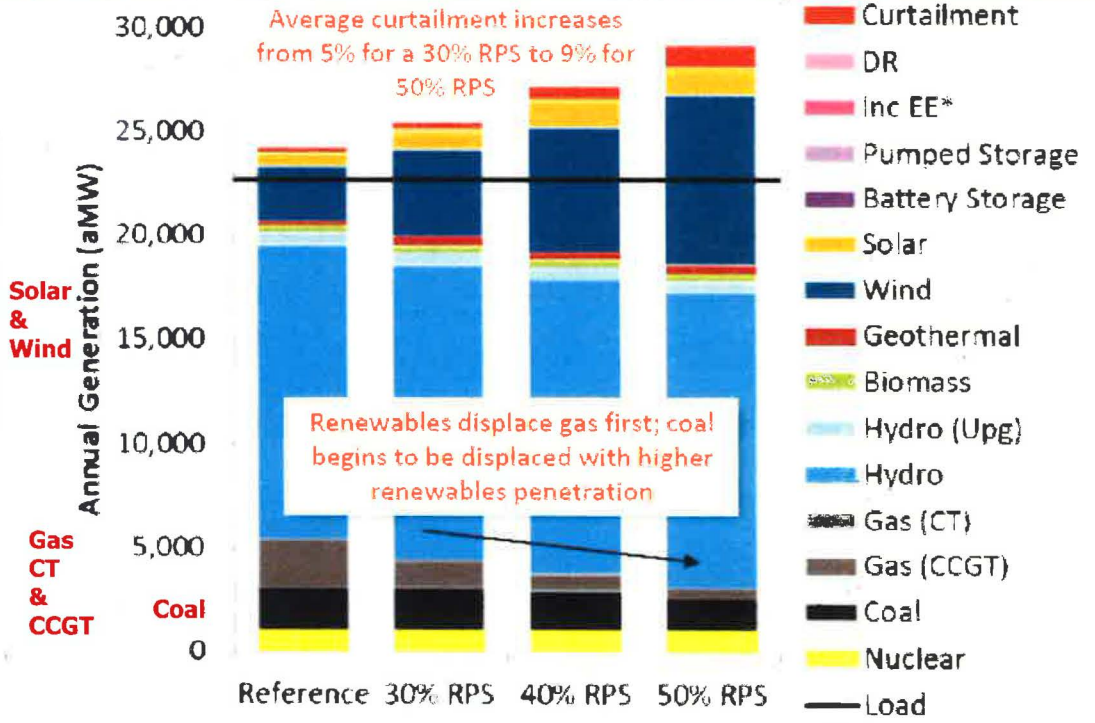
- 23 GW of new renewables needed to meet a 50% RPS by 2050
- Curtailment increases to 9% of available renewable energy
- Coal provides most thermal energy

Scenario	Inc Cost ($MM/yr.)	GHG Reductions (MMT)	Effective RPS %	Zero CO2 %
Reference	—	—	20%	91%
30% RPS	+$330	4.3	30%	101%
40% RPS	+$1,077	7.5	40%	111%
50% RPS	+$2,146	11.5	50%	121%

Resources Added (MW)



Energy Balance (aMW)



* EE shown here is incremental to efficiency included in load forecast (based on NWPCC 7th Plan)

Retirement of Existing Zero-Carbon Generation

- **In order to highlight the value of existing zero carbon (non-RPS-qualifying) resources—and their key role in meeting GHG goals—E3 evaluated a sensitivity in which approximately 2,000 aMW of nuclear & hydro was assumed to retire:**
  - Columbia Generating Station (1,207 MW)
  - 1,000 aMW of generic existing hydro
- **Sensitivity analysis conducted on Reference Case (current policy), 80% GHG Reduction Case and 50% RPS Case**

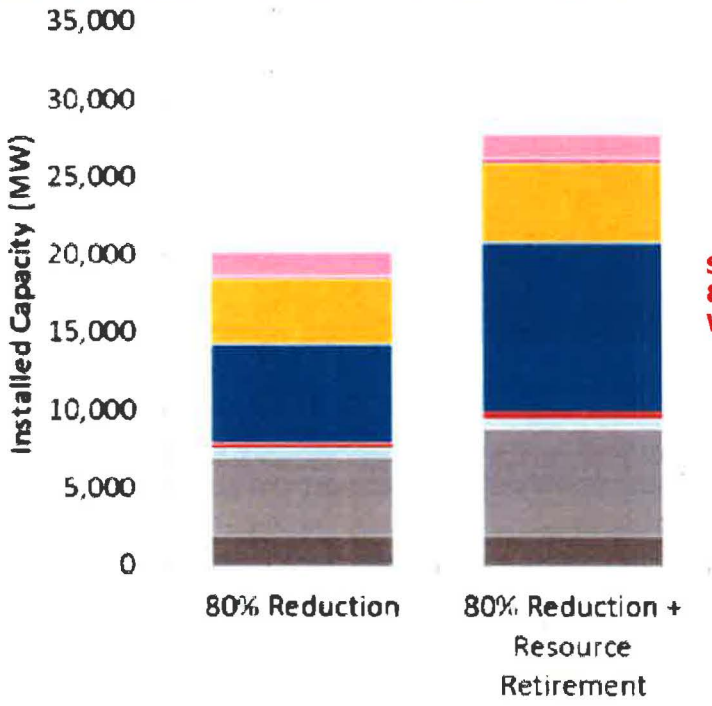
2050 Portfolio Summary
80% Reduction (Existing Resource Retirement)

Highlights

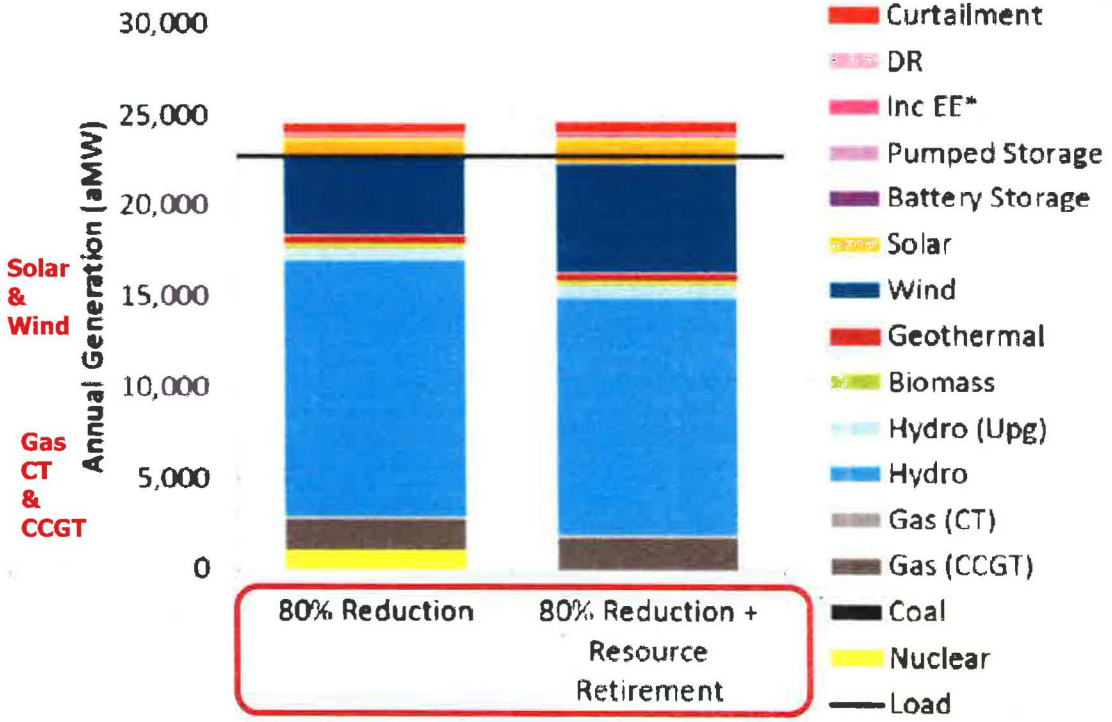
- Under 80% GHG reduction scenario, retiring carbon-free resources replaced with 5.5 GW of renewables and 2 GW of gas
- Cost to meet goal increases $1.6 B

Scenario	Inc Cost ($MM/yr.)	GHG Reductions (MMT)	Effective RPS %	Zero CO2 %
Base	+$1,046	20.9	31%	102%
Retirement Case	+$2,652	20.9	40%	102%
Delta	+$1,606	—	+9%	—

Selected Resources (MW)

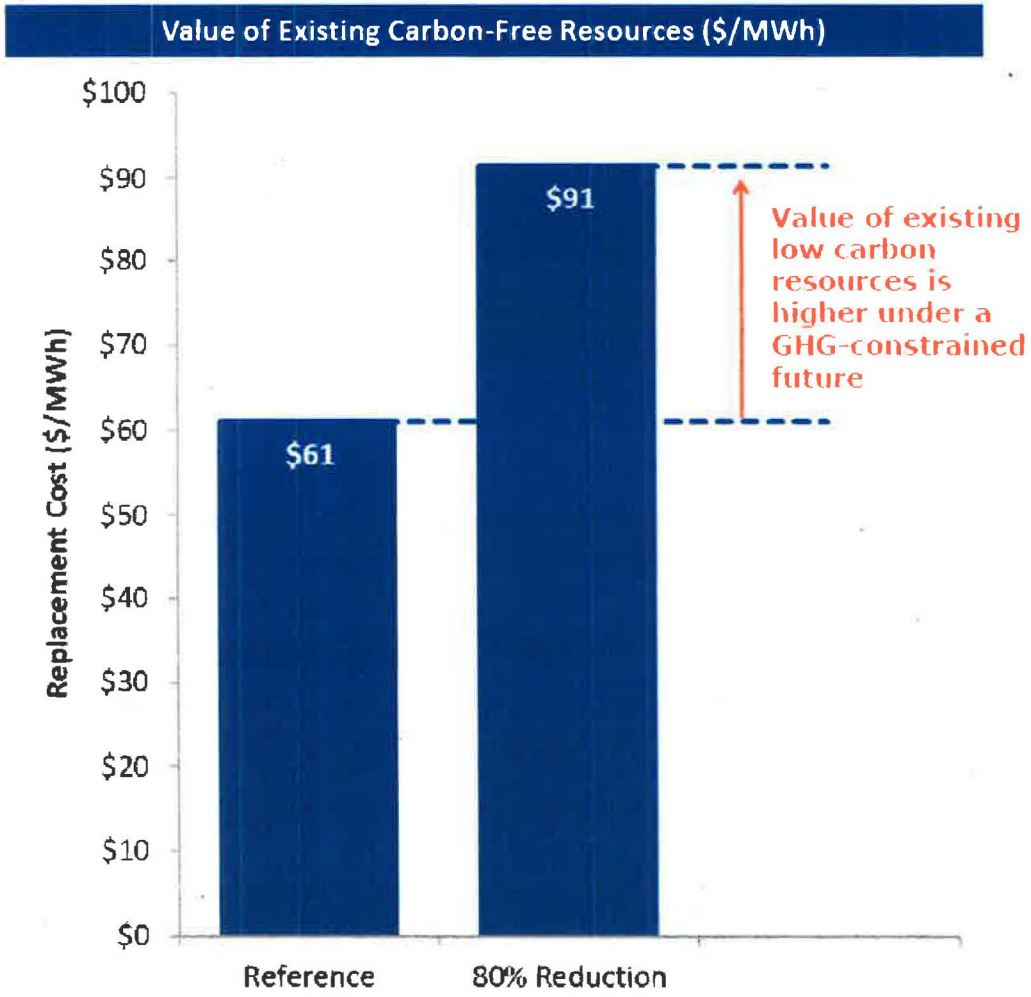


Energy Balance (aMW)



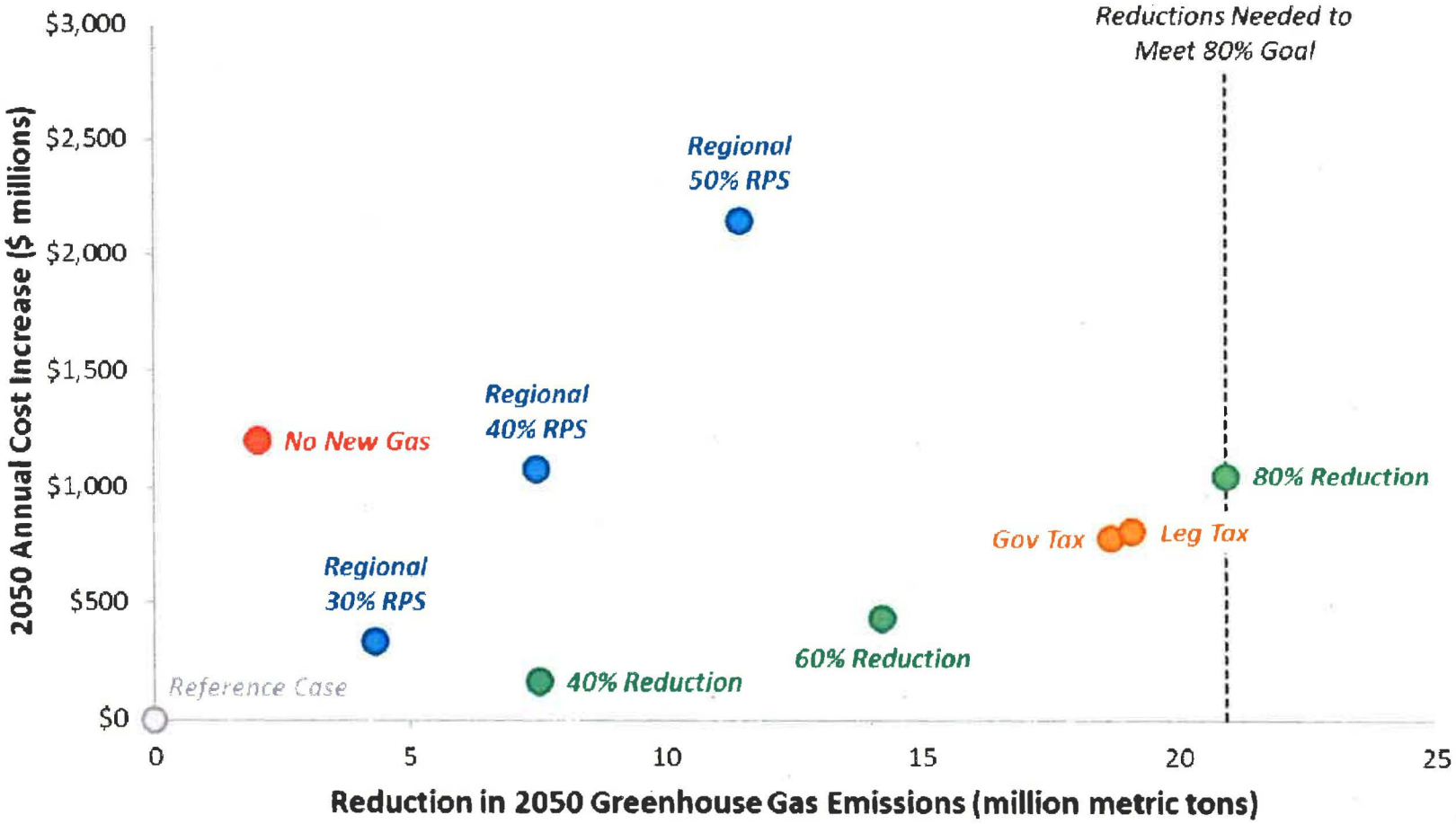
* EE shown here is incremental to efficiency included in load forecast (based on NWPCC 7th Plan)

Value of Existing Zero Carbon Gen Increases Under GHG Constraints



- In the Reference Case, lost capacity and energy is replaced with natural gas generation
- In the 80% GHG Reduction Case, lost energy is replaced with 5500 MW of renewables and lost capacity is replaced with 2000 MW of gas generation
- Higher value in a carbon constrained world reflects the significant increase in cost to meet GHG policy goals should existing low carbon resources retire

Cost & Emissions Impacts
All Cases



Note: Reference Case reflects current industry trends and state policies, including Oregon's 50% RPS goal for IOUs and Washington's 15% RPS for large utilities

Key Findings (1 of 3)

1. **The most cost-effective opportunity for reducing carbon in the Northwest is to displace coal generation with a combination of energy efficiency, renewables and natural gas**
   - Coal generation produces approximately 80% of the Northwest's electricity-sector GHG emissions today
   - A technology-neutral policy that focuses on carbon provides incentives for leveraging the lowest-cost GHG emissions reductions
2. **Renewable generation is an important component of a low-carbon future, however a Renewables Portfolio Standard results in higher costs and higher carbon emissions than a policy that focuses directly on carbon**
   - RPS policy has been successful at driving investment in renewables but ignores other measures such as energy efficiency and coal displacement
   - RPS policy has unintended consequences such as oversupply and negative wholesale electricity prices that create challenges for reinvestment in existing zero-carbon resources

Key Findings (2 of 3)

3. Prohibiting the construction of new natural gas generation adds significant cost but does little to save GHG emissions

- Older gas plants run at a higher capacity factor and generate more carbon emissions
- More study is needed to determine whether the system modeled has sufficient energy and capacity to meet resource adequacy requirements
- Building new gas resources for capacity is part of a least-cost portfolio even under carbon-constrained scenarios

4. Meeting decarbonization goals becomes significantly more challenging and costly should existing zero-carbon resources retire

- Replacing 2,000 aMW of existing hydro or nuclear generation would require nearly 6,000 MW of new wind and solar generation and 2,000 MW of natural gas generation at an annual cost of $1.6 billion by 2050
- A policy that encourages the retention of existing zero-carbon generation resources will help contain costs of meeting carbon goals

Key Findings (3 of 3)

5. **Returning revenues raised under a carbon pricing policy to the electricity sector is crucial to mitigate higher costs**
   - This is a common feature of carbon pricing programs adopted in other jurisdictions
   - This helps ensure that electricity ratepayers are not required to pay twice: first for the cost of investments in GHG abatement measures, and second for the emissions that remain
6. **Research and development is needed for the next generation of Energy Efficiency measures**
   - Higher-cost measures that have not traditionally been considered may become cost-effective in a carbon-constrained world
7. **Vehicle electrification is a low-cost measure for reducing carbon emissions in the transportation sector**
   - Electrification has benefits for society as a whole, but may increase costs in the electric sector

Key Take Aways

- Pursue policies that are adaptable and provide for a least-cost approach to emission reductions
- Implement an economy-wide price on carbon rather than technology specific mandates
- Replace coal with the least-cost combination of renewable energy, natural gas and other technologies to meet energy and capacity needs
- Advance the next generation of energy efficiency measures
- Preserve and enhance existing hydro and nuclear power
- Support electrification of transportation with cross-sector considerations of funding and analysis

Next Steps

- Share and discuss results with the interested parties in the NW
- Explore methods and approaches for advancing a least-cost, high effectiveness approach to carbon emission reductions in the electric sector
- Expand methodology to a multi-sector approach