

# Integrated Resource Plan Update

Prepared for:

**City of Pasadena Water and Power Department**

February 22, 2012

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Further, certain statements, findings and conclusions in this Report are based on Pace Global's interpretations of various contracts. Interpretations of these contracts by legal counsel or a jurisdictional body could differ.

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## EXECUTIVE SUMMARY

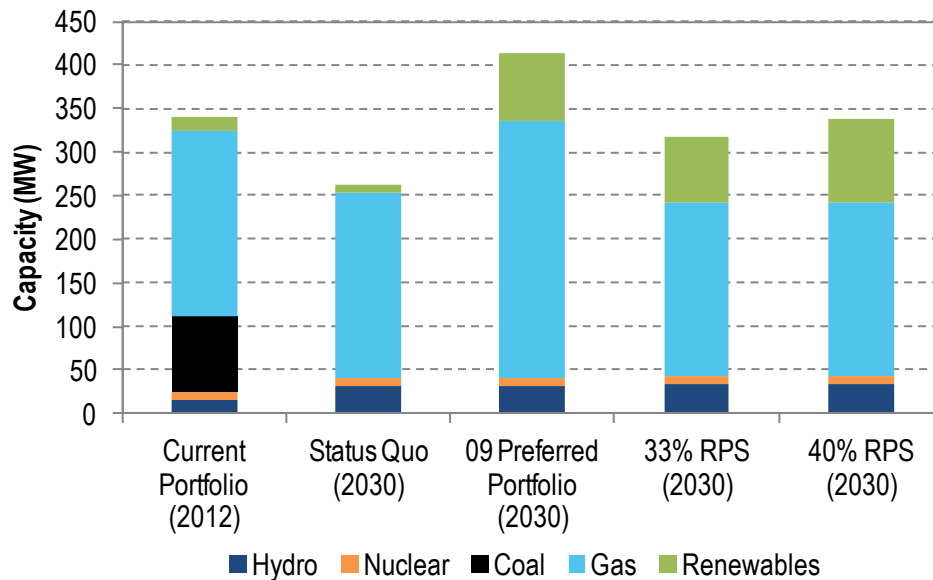
In this 2012 update to the City of Pasadena’s Integrated Resource Plan (“2012 IRP”), Pace Global Energy Services, LLC (“Pace Global”) has assessed the cost and environmental performance of Pasadena Water and Power’s (“PWP”) existing Preferred Resource Plan against the status quo and against portfolio options intended to meet and exceed the new statewide 33% Renewable Portfolio Standard (“RPS”). Covering the period from 2012 through 2030 (“Study Period”), this report includes a summary of the future performance of PWP’s electric portfolio.

Pace Global has reassessed a set of updated portfolio options consistent with revised market input assumptions and PWP’s latest renewable contract price offers. The analysis has considered four distinct long-term portfolio constructs:

- *Status Quo*
- *Preferred Plan from 2009 IRP* – updated for any new contracts or portfolio developments since 2009
- *Least Cost Portfolio to Meet the 33% RPS Standard (“State Mandate”)*
- *Least Cost Portfolio to Meet a 40% RPS Standard (“2012 RPS”)*

Exhibit 1 summarizes the total capacity mix by fuel type in 2030 for each of the portfolios compared with PWP’s current portfolio. Exhibit 2 displays the same comparison for total portfolio generation. The subsequent chapters of this report present the detailed incremental capacity changes over time.

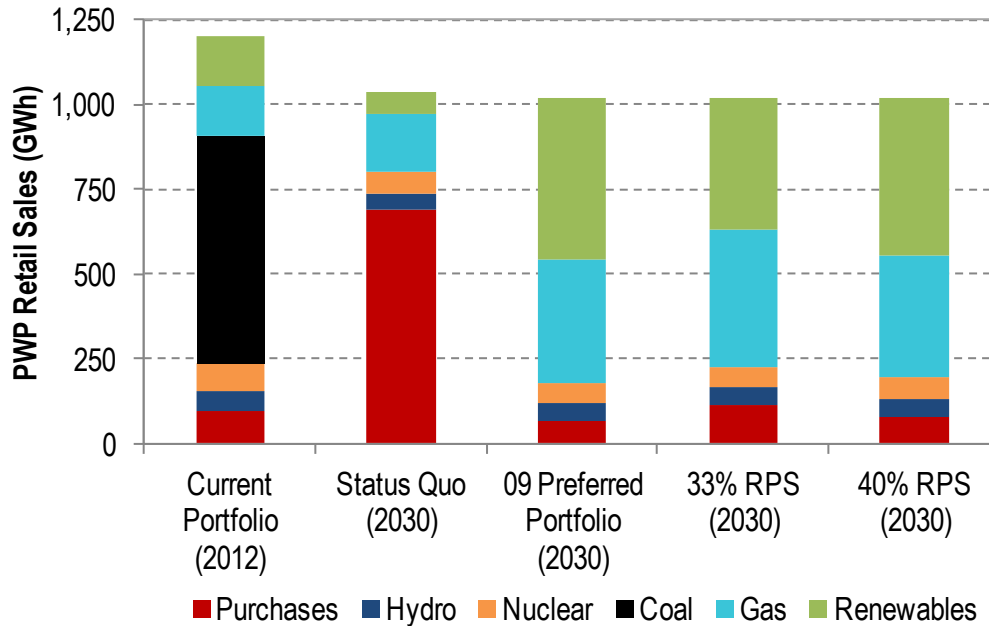
**Exhibit 1: Comparison of Current Portfolio Capacity vs. 2030 Capacity Portfolio Options**



\*Note that the “Current Portfolio” represents PWP’s existing capacity and includes no changes or contract additions/expiries over time.

Source: Pace Global

**Exhibit 2: Generation Resource Comparison**



\*Note that the “Current Portfolio” represents PWP’s existing generation from resources and market purchases and includes no changes or contract additions/expiries over time. The “Current Portfolio” also maintains existing load for PWP’s system.  
Source: Pace Global

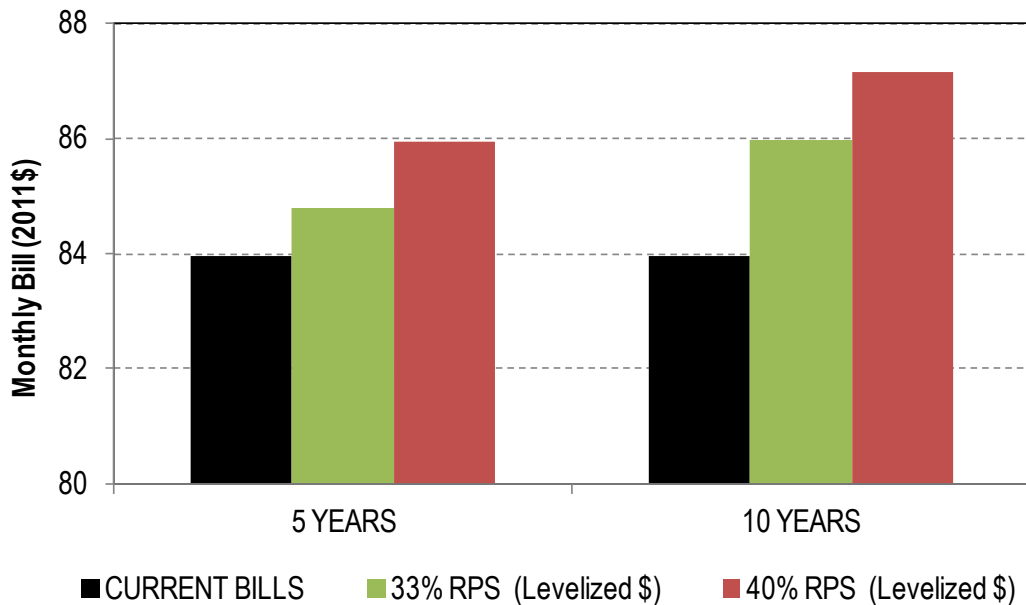
The findings of this update include the following:

- Lower long term pricing expectations for natural gas, CO<sub>2</sub> compliance costs, and California power market prices result in generally lower portfolio cost increases than those expected in the 2009 IRP.
- Additional renewable resource procurement and demand response and efficiency deployment is associated with higher portfolio costs. The 33% RPS portfolio is expected to have levelized portfolio costs about four percent higher than those under current status quo conditions, while extending to a 40% RPS results in an *additional* two percent increase in real dollar levelized costs (interpreted as representative of higher costs *every* year of the Study Period). During the middle years of the Study Period, the 33% RPS case has seven to 14 percent higher expected costs in real dollar terms than the Status Quo.
- The average cost over the next five years for the 33% portfolio is about two percent higher than current costs, with the 40% RPS portfolio having five percent higher average costs. In addition to incremental renewable additions, expected increases in fuel prices contribute to the expected rise in overall costs. Free allowances associated with CO<sub>2</sub> emissions help mitigate other increases.
- The additional costs associated with the 33% RPS portfolio are expected to result in a \$0.0017/kWh increase in the energy portion of a customer’s bill over the next five years, and a \$0.0023/kWh increase in the energy portion of a customer’s bill over the next ten years. The 40% RPS portfolio is expected to result in an additional \$0.002/kWh increase in the energy portion of a customer’s bill beyond the increase already expected with the 33% RPS.
- Thus, over the next five years, a residential customer consuming an average of 500 kWh per month would be expected to face an average monthly bill increase of about one dollar in *real terms* under the 33% RPS portfolio. An additional one dollar increase would be expected under a move to the 40% RPS portfolio. Over a ten year term, the increase for the 33% RPS portfolio is

expected to be about two dollars. The 40% RPS portfolio maintains an approximately one dollar additional increase. This is shown in Exhibit 3.

- Every 1% increase in RPS percentage by 2020 is associated with an increase of \$0.20/MWh (\$0.0002/kWh) in portfolio costs on a levelized basis.
- The 2009 Preferred Plan is now reflective of a 40 to 50% RPS portfolio, given revised load and energy efficiency expectations as well as new biogas contracts that count towards RPS compliance.
- Higher renewable percentages can help mitigate risks associated with higher than expected natural gas and CO<sub>2</sub> compliance costs, but result in a more sizeable premium over the status quo if a low natural gas/CO<sub>2</sub> price environment persists.

**Exhibit 3: Residential Customer Bill Comparison – 500kWh/mo Annual Avg. Usage**



Source: Pace Global and PWP analysis

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## PLANNING ENVIRONMENT AND OBJECTIVES

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### SITUATION ASSESMENT

PWP faces significant changes to the regulatory and market environment since it last completed its Integrated Resource Plan during 2008 and early 2009. Since then, the following developments have occurred:

- California has passed a 33% RPS for all load serving entities (“LSEs”) by 2020 with interim targets of 20% of all retail sales by 2013 and 25% by 2016 (see additional details below);
- California’s AB 32 greenhouse gas reduction law is on track to begin pricing CO<sub>2</sub> emissions in 2013, while federal action has been postponed indefinitely;
- Depressed economic conditions throughout the region and the country have contributed to weak electric load growth and soft demand for commodities;
- Weak economic conditions and continued advancement in natural gas production from domestic shale resources has lowered the expected pricing outlook for natural gas prices. This results in lower electric power price expectations in California.

### California RPS

During the development of the last IRP assessment in 2008-2009, California’s RPS mandate required regulated electric utilities and suppliers to purchase 20% of their electricity from renewable sources by 2010, although municipal entities like PWP were exempted from compliance. Separately, Governor Schwarzenegger had issued Executive Order S-21-09, calling for 33% of the state’s generation from renewable sources by 2020. In addition to raising the state’s renewable target, Executive Order S-21-09 also made RPS compliance mandatory for publically owned municipal utilities and electric cooperatives. This 33% standard was codified into state law with the enactment of SBX1-2 in April 2011, and enactment of the law will be carried out by the California Energy Commission (“CEC”) for publically-owned utilities (“POU”) like PWP and the California Public Utility Commission (“CPUC”) for non-POU load serving entities.

Some provisions of the 33% RPS are still being finalized, but the prominent design elements include:

- 33% qualified renewable energy for all LSEs by 2020 with interim targets: An average of 20% of retail sales for the compliance period from January 1, 2011 to December 31, 2013, inclusive, and 25% by December 31, 2016;
- Eligible technologies include wind, solar, geothermal, ocean technologies, landfill gas, digester gas, renewable fuel cells, and certain configurations of hydro, biomass and municipal solid waste;
- The CEC will certify eligible renewable facilities and compliance;
- The CEC and the California Air Resources Board (“CARB”) will enforce compliance for POU’s;
- Tradable RECs (“TRECs”), unbundled RECs from the associated power, generated in states located within the Western Electricity Coordinating Council (“WECC”) may be used for up to 25% of compliance requirements through 2013, declining to 10% of total requirements by 2017.

Under this backdrop, Pace Global has updated several key planning drivers for the reference portfolio assessment and across a range of potential market outcomes (see section on MarketLink Scenarios for detailed assumptions). This allows for a risk-based evaluation of different portfolio options against updated market assumptions.

## **SUMMARY OF KEY PLANNING OBJECTIVES**

As in the 2009 IRP, PWP is primarily focused on the objectives of reliability, cost, and environmental compliance and stewardship. These three objectives have consistently ranked highest for various stakeholders.

### **Reliability**

System reliability is a primary concern for PWP, and long-term utility planning is done using a capacity reserve margin target. In this context, PWP plans to have reliable resources in place to meet its customers' expected demand plus a margin (15-18%) in order to ensure reliability even after the loss of one or more key resources. Reliability planning for PWP is complicated by the fact that PWP has only a single interconnection with the CAISO grid, and the loss of that interconnection would have very serious reliability consequences. Due to PWP's dependence on a single 215 MW transmission line into the City, PWP historically has placed significant reliance on maintaining local generation inside the City to mitigate those reliability consequences, and any portfolio that includes additional local generation reduces PWP's reliance on that line to serve load. This update considers the same local capacity requirements as in the 2009 IRP.

### **Cost**

#### ***Preserve Competitive Rates***

Preserving competitive rates is a common objective for utilities. For comparison purposes, different portfolio options were evaluated based on the levelized net present value of all generation-related costs associated with serving the utility's load. Pace Global's cost metric includes the variable cost of generation, fixed costs, capital cost investments, and the cost of net market transactions (purchases minus sales). Portfolio costs include all direct costs associated with greenhouse gas compliance, but do not include any additional market externalities.

#### ***Maintain Stable Rates***

Portfolios that can mitigate significant market swings can achieve higher rate stability over time for PWP's customers. Portfolios were evaluated against a range of key market drivers, like natural gas prices, energy demand, and power market prices as summarized in the section on MarketLink Scenarios. In this context, portfolios were evaluated based on the difference between the high and low cost outcomes across these range of market drivers. This represents a metric of how wide the distribution of costs can get for each portfolio. The lower the difference, the less exposed the portfolio is to market volatility.

### **Environmental Compliance and Stewardship**

Environmental compliance and stewardship is an important objective for PWP. Portfolio development is focused on meeting standards for renewables, as well as reductions in CO<sub>2</sub> emissions associated with state law. Additional environmental stewardship above defined standards has also been considered. The key metrics used in Pace Global's analysis include RPS percentage and CO<sub>2</sub> emission reductions from a baseline year.



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## PWP PORTFOLIO DEVELOPMENT

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In order to assess the key tradeoffs for PWP against the major planning objectives and metrics, Pace Global developed four portfolios to study:

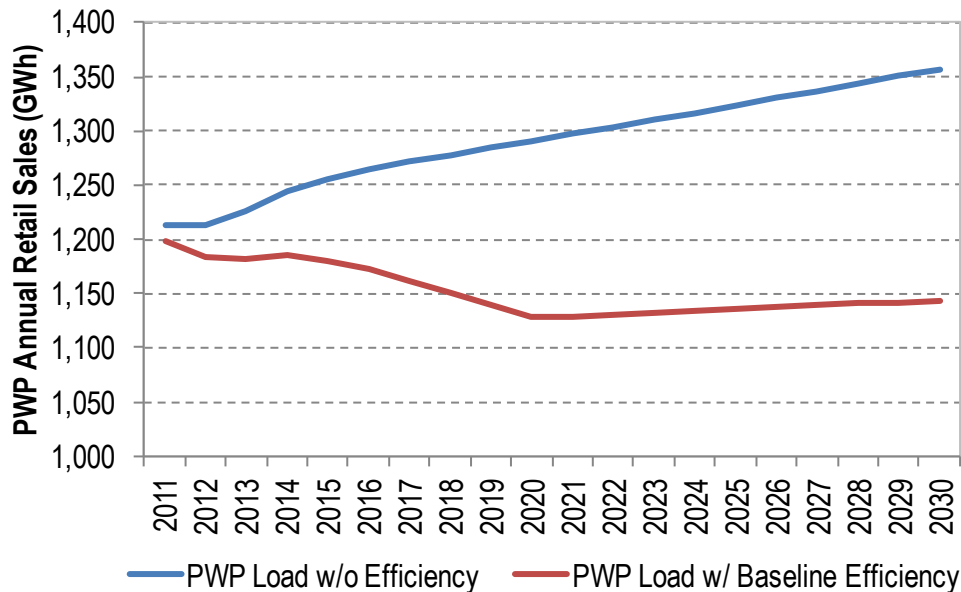
- *Status Quo* – existing system and current resources under contract, with no incremental changes.
- *Preferred Plan from 2009 IRP* – updated for any new contracts or portfolio developments since 2009 and re-adjusted to conform with Preferred Plan.
- *Least Cost Portfolio to Meet the 33% RPS Standard (“State Mandate”)*
- *Least Cost Portfolio to Meet a 40% RPS Standard* – assuming a relatively linear path in RPS growth between now and a 40% target in 2020 (“2012 RPS”)

### PWP LOAD FORECAST

In assessing future load requirements, Pace Global has used PWP’s 2011 IRP load forecast. Load erosion from the recent economic downturn is expected to recover in the 2013-2015 time period, with a long-term growth rate of approximately 0.5% per year expected. PWP has also developed energy efficiency scenarios as part of the triennial Energy Efficiency Goal adoption process. Exhibit 4 summarizes the net energy for load forecasts with and without energy efficiency penetration. The portfolio analysis has been conducted *with* the inclusion of the baseline energy efficiency goals.

**Exhibit 4: Current PWP Load Forecast with and without Energy Efficiency**

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Source: PWP

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### EXISTING PORTFOLIO COMPOSITION

The City of Pasadena currently has about 200 MW of on-site, natural gas-fired local generation and is capable of importing up to 215 MW more through its interconnection with Southern California Edison. PWP also has ownership shares and long term contracts with a number of power generation facilities



located throughout the West. A summary of the existing portfolio and biogas delivery contracts is shown in Exhibit 5. Although the majority of the portfolio's installed capacity is natural gas-fired, PWP relies on power generation from the coal-fired Intermountain Power Plant IPP for over 60% of its current energy needs.

Pace Global includes all newly signed renewable contracts in the current PWP generation mix. Although PWP has been pursuing a share of the La Paz solar renewable energy project located in Arizona, at the time this 2012 IRP was prepared, contractual issues beyond PWP's control have caused uncertainty in PWP's continued participation in the project. Therefore, the La Paz project was not included as part of PWP resource portfolio for this 2012 IRP.

Electricity generated from the biogas deliveries specified in Exhibit 5 contributes to renewable generation credit for the portfolio. In assessing and tracking renewable credit, Pace Global has assumed that the biogas deliveries will be burned in the Magnolia combined cycle plant. This is because Magnolia's heat rate provides the most efficient conversion from biogas fuel to power for the portfolio.

**Exhibit 5: Current PWP Generation Portfolio Details**

Plant Name (Contractor)	Unit Type	Primary Fuel	Start	End	Capacity (MW)
Intermountain Power Project	Steam Turbine	Coal	1980	2027	108
Hoover Power Plant	Hydro	Hydro	1941	2067	20
Azusa	Hydro	Hydro	1933	-NA-	15
Palo Verde	Steam Turbine	Nuclear	1981	2030	9.9
Broadway	Steam Turbine	Gas	1965	-NA-	65
Glenarm	Combustion Turbine	Gas	1975	-NA-	22.3
	Combustion Turbine	Gas	1975		22.3
	Combustion Turbine	Gas	2004		42.4
	Combustion Turbine	Gas	2004		44.8
Magnolia Power Plant	Combined Cycle	Gas	2005	-NA-	19
BPA Exchange	Contract	Contract	1995	2015	15
High Winds (Iberdrola)	Wind Turbine	Wind	2003	2023	2
Milford (UPC/First Wind)	Wind Turbine	Wind	2009	2029	5
Heber South (Ormat)	Steam Turbine	Geothermal	2006	2031	2.1
Tulare & West Covina Landfill (Minnesota Methane)	Combustion Turbine	Landfill Gas	2007	2016	9.5
Chiquita Canyon Landfill (Ameresco)	Combustion Turbine	Landfill Gas	2010	2030	6.7
La Paz Solar Tower*	Pressure Staged Turbine	Solar	2015	2045	10
DWP-IID Area 1 Geothermal	Steam Turbine	Geothermal	2018	2047	1
<b>Total 2012 Capacity:</b>					<b>340</b>

Biogas Supplier	Start	End	Biogas Delivery for 2012 (MMBtu/day)
EDF	2011	2021	545
Sequent	2011	2021	610
WM	2011	2021	900
<b>Average Daily 2012 Biogas Delivered</b>			<b>1,965</b>

Note that capacity indicates full nameplate or contract specifications. Where appropriate, Pace Global has adjusted capacity numbers to incorporate actual availability for PWP. For instance, Hoover capacity declines by 5% after 2017.

\*Although PWP has been pursuing a share of the La Paz solar renewable energy project located in Arizona, contractual issues beyond PWP's control have caused uncertainty in PWP's continued participation in the project. Therefore, the La Paz project was *not* included as part of PWP's resource portfolio.

Source: PWP

## NEW PORTFOLIO DEVELOPMENT

Pace Global developed additional portfolios for study using the PWP screening tool that was deployed during the 2008-2009 IRP process. The screening tool allows for rapid assessment of the impacts of incremental portfolio changes (additions or subtractions from the existing portfolio mix) on portfolio costs and environmental performance. The Preferred Plan from the 2009 IRP was preserved and updated to reflect any actual changes to PWP's portfolio over the past two to three years. A summary of the incremental portfolio from the 2009 IRP is shown in Exhibit 6.

The additional 33% and 40% RPS portfolios, Exhibit 9 and Exhibit 10, respectively, were developed to achieve lowest portfolio costs under Reference Case market conditions and an indicative range of costs for new renewables from recent offers available to PWP. These portfolios were created through a technology screening process that tested dozens of combinations of options within PWP's system and at an hourly level of dispatch granularity.

**Exhibit 6: Incremental Portfolio Changes for 2009 Preferred Resource Plan**

Year	Remote Renewables (MW)				Local Renewables (MW)			Fossil (MW)		
	LFG	Geo	Wind	Solar	DR	Solar PV	Feed-in Tariff	CC	Gas Steam	Coal
2008						0.9				
2009						1.0				
2010						1.1	0.7			
2011						1.1	0.7			
2012	5	5	5	5	5	1.2	0.7			
2013						1.4	0.7			
2014						1.5	0.7			
2015						1.7	0.7	65	-65	
2016	5	5	5	5		1.9	0.7			-35
2017	5	5				2.2	0.7			
2018						0.7	0.7			
2019						0.7	0.7			
2020			10	10		0.7	0.7			
2021						0.7	0.7			
2022						0.7	0.7			
2023						0.7	0.7			
2024						0.7				
2025										
<b>Total</b>	<b>15</b>	<b>15</b>	<b>20</b>	<b>20</b>	<b>5</b>	<b>19</b>	<b>10</b>	<b>65</b>	<b>-65</b>	<b>-35</b>

Source: Pace Global, 2009 PWP IRP, and PWP

## Renewable Costs

Since most incremental generation capacity additions will come from renewable resources in order to meet environmental standards, Pace Global has updated renewable resource costs for this 2012 IRP using market quotes offered to PWP. Given the uncertainty in cost estimates and the likelihood that costs could change over time for renewable contract purchases, Pace Global has developed two separate tiers for renewable technologies by type. The first tier is representative of near-term contract opportunities available to PWP, but is capped at 10 MW for each technology, recognizing that competition exists for these resources. The second tier represents higher cost contracts after the most competitive bids are exhausted or in response to other upward market pressures. Developing two tiers of costs also incorporates PWP's need for diversity in acquiring renewable generation by not assuming one renewable

type will be consistently available at a single price. Diverse renewable options allow PWP to supply resources from a range of options that have different cost and availability profiles.

Exhibit 7 summarizes renewable costs by technology type, while Exhibit 8 shows the costs along with assumed regional capacity factors for each technology. Note that in Pace Global’s analysis, all renewable costs include appropriate transmission or shaping charges associated with entry to the CAISO and PWP’s system.

**Exhibit 7: Summary of Renewable Capacity Availability at Cost Tiers**

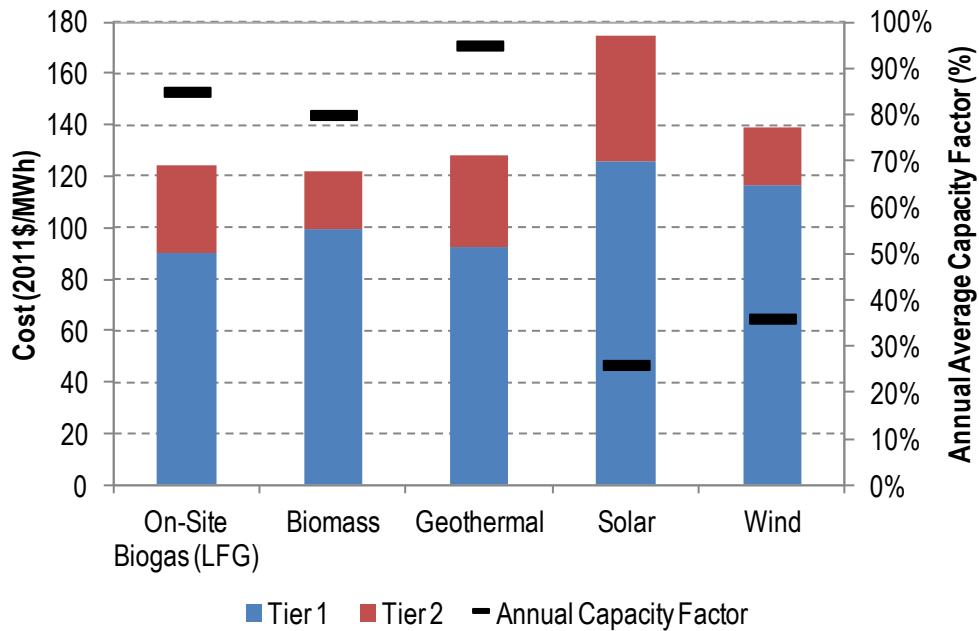
	Tier I (Levelized 2011\$/MWh)	Tier II (Levelized 2011\$/MWh)
<b>Biogas (LFG) Total</b>	\$90.21	\$123.90
<b>Biomass Total</b>	\$99.12	\$122.23
<b>Geothermal Total</b>	\$92.43	\$128.48
<b>Solar Total</b>	\$125.87	\$174.71
<b>Wind Total</b>	\$116.34	\$138.72

Note: Includes a transportation and integration fee to LADWP for non-California assets

Note: Pace Global has included relevant contract terms and escalation rates associated with recent contract offers in the analysis. The inflation rates used to convert contract terms into real 2011\$ are provided in Appendix I. This table summarizes the levelized values over the Study Period.

Source: Pace Global and PWP market quotes

**Exhibit 8: Renewable Cost Tiers and Capacity Factors**



Source: Pace Global and PWP

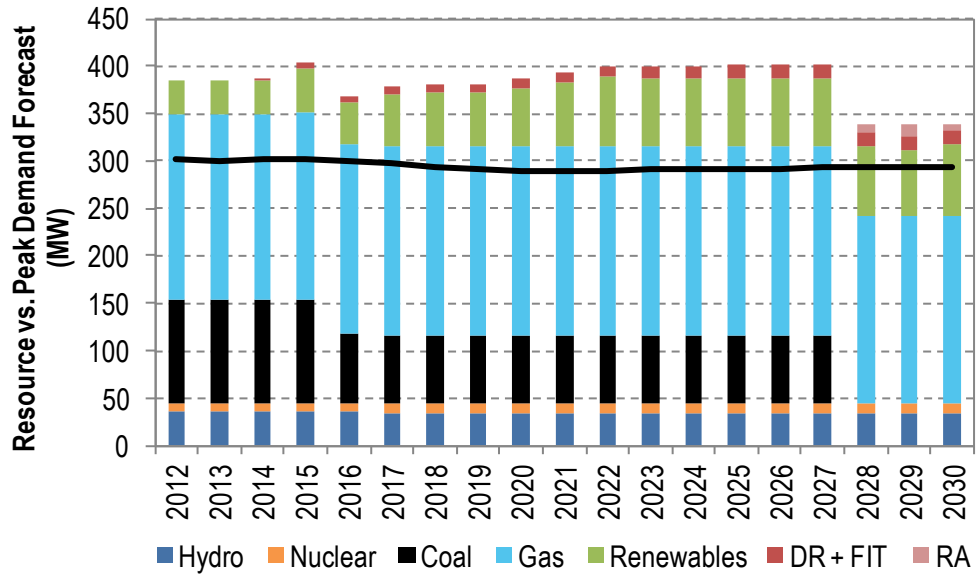
In assessing the lowest cost technology mix to meet the RPS standards, Pace Global arrived at a relatively diverse set of technology additions over time. Biomass and landfill gas options are preferred due to comparatively lower relative costs per MWh and higher availability, along with geothermal resources available at the lower cost tier. Solar and wind contract additions are attractive within the portfolio after the lower cost baseload options have been exhausted. Exhibit 9 and Exhibit 11 summarize the incremental capacity changes over time associated with the 33% and 40% RPS portfolios, respectively. Exhibit 10 shows PWP's resources under the 33% RPS portfolio versus forecasted peak load throughout the Study Period. Exhibit 12 does the same for the 40% RPS portfolio.

**Exhibit 9: Incremental Portfolio Changes for 33% RPS Portfolio**

Year	Remote Renewables (MW)					Local Renewables (MW)			Fossil (MW)		
	LFG	Biomass	Geo	Wind	Solar	DR	Solar PV	Feed-in Tariff	CC	Gas Steam	Coal
2012							1.2				
2013							1.4				
2014							1.5	0.7			
2015						5	1.7	0.7	67	-65	
2016							1.9	0.7			-35
2017	10						2.2	0.7			
2018							0.7	0.7			
2019							0.7	0.7			
2020		5					0.7	0.7			
2021		5					0.7	0.7			
2022			7				0.7	0.7			
2023							0.7	0.7			
2024			1				0.7	0.7			
2025							0.7	0.7			
2026							0.5	0.7			
2027								0.7			
2028											-73
2029			2								
2030				3	3						
<b>Total</b>	<b>10</b>	<b>10</b>	<b>10</b>	<b>3</b>	<b>3</b>	<b>5</b>	<b>16</b>	<b>10</b>	<b>67</b>	<b>-65</b>	<b>-108</b>

Source: Pace Global

**Exhibit 10: 33% RPS Resources vs. Peak Demand Forecast**



\*DR = "Demand Response," FIT = "Feed In Tariff," and RA = "Resource Adequacy."

\*Note that a small amount of market-based Resource Adequacy purchases are included after 2027 to maintain reserve margin levels at 15%.

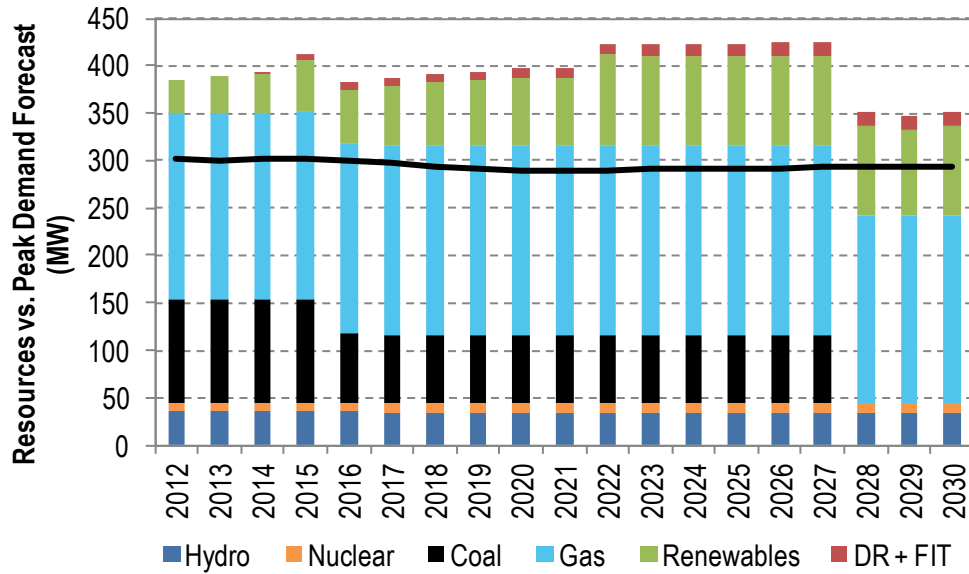
Source: Pace Global and PWP

**Exhibit 11: Incremental Portfolio Changes for 40% RPS Portfolio**

Year	Remote Renewables (MW)					Local Renewables (MW)			Fossil (MW)		
	LFG	Biomass	Geo	Wind	Solar	DR	Solar PV	Feed-in Tariff	CC	Gas Steam	Coal
2012							1.2				
2013	4						1.4				
2014	2						1.5	0.7			
2015	3					5	1.7	0.7	67	-65	
2016	1	3					1.9	0.7			-35
2017		5					2.2	0.7			
2018		2					0.7	0.7			
2019			3				0.7	0.7			
2020			2				0.7	0.7			
2021							0.7	0.7			
2022			5	10	10		0.7	0.7			
2023							0.7	0.7			
2024							0.7	0.7			
2025							0.7	0.7			
2026							0.5	0.7			
2027								0.7			
2028											-73
2029											
2030	5										
<b>Total</b>	<b>15</b>	<b>10</b>	<b>10</b>	<b>10</b>	<b>10</b>	<b>5</b>	<b>16</b>	<b>10</b>	<b>67</b>	<b>-65</b>	<b>-108</b>

Source: Pace Global

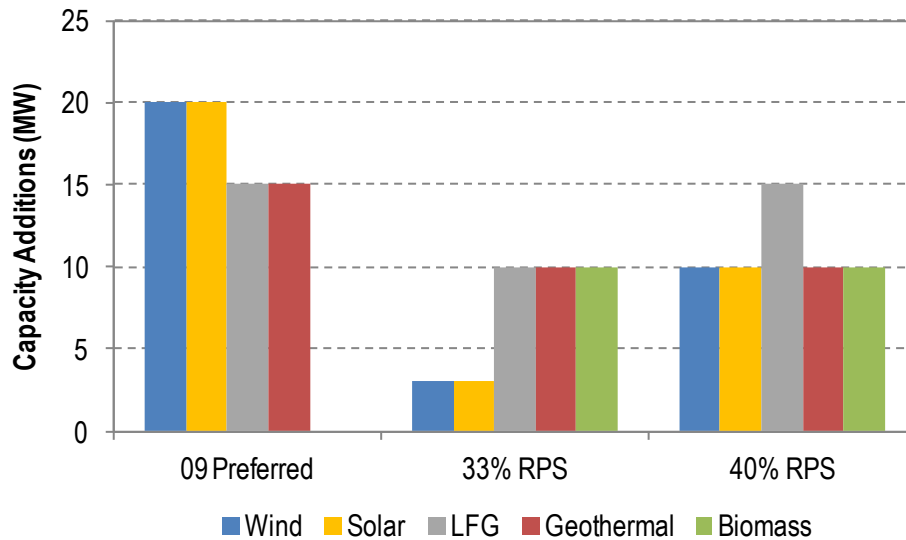
**Exhibit 12: 40% RPS Resources vs. Peak Demand Forecast**



\*DR = "Demand Response" and FIT = "Feed In Tariff"  
 Source: Pace Global and PWP

Exhibit 13 summarizes the total incremental capacity additions for each portfolio through the 2030 time period. The new 33% and 40% RPS portfolios are slightly weighted towards baseload renewable additions, with the 2009 Preferred Portfolio having slightly more wind and solar capacity and no biomass.

**Exhibit 13: Total Renewable Capacity Additions by Portfolio**



Source: Pace Global

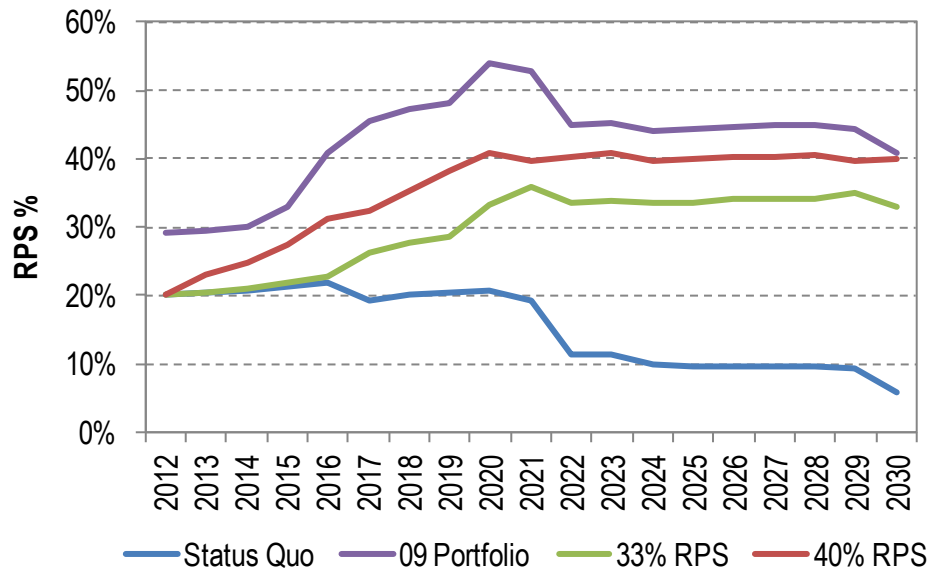


## PORTFOLIO ASSESSMENT

### REFERENCE CASE CONCLUSIONS

Overall, the portfolio analysis indicates that higher levels of renewables result in a higher cost profile for the portfolio against the status quo in nearly all market conditions. Exhibit 14 summarizes the renewable percentage for each portfolio over time under reference case conditions. As constructed, the status quo portfolio stays at around 20% in the early years and declines as contracts roll off. The 33% (“State Mandate”) portfolio achieves the incremental state targets and 33% by 2020. The 40% (“2012 RPS”) ramps up at a faster rate and in a linear fashion with the target reached by 2020, with the 2009 IRP portfolio having a higher RPS due to lower PWP load growth and significant new biogas consumption.

**Exhibit 14: Renewable Percentage over Time – Reference Case Market Conditions**



Source: Pace Global

Over the 20-year study period under reference conditions, the 33% compliance portfolio results in a 4% levelized cost increase above and beyond status quo conditions (reflective of the average additional costs every year). This increase is less than the difference projected in the 2009 IRP (6%) for the following reasons:

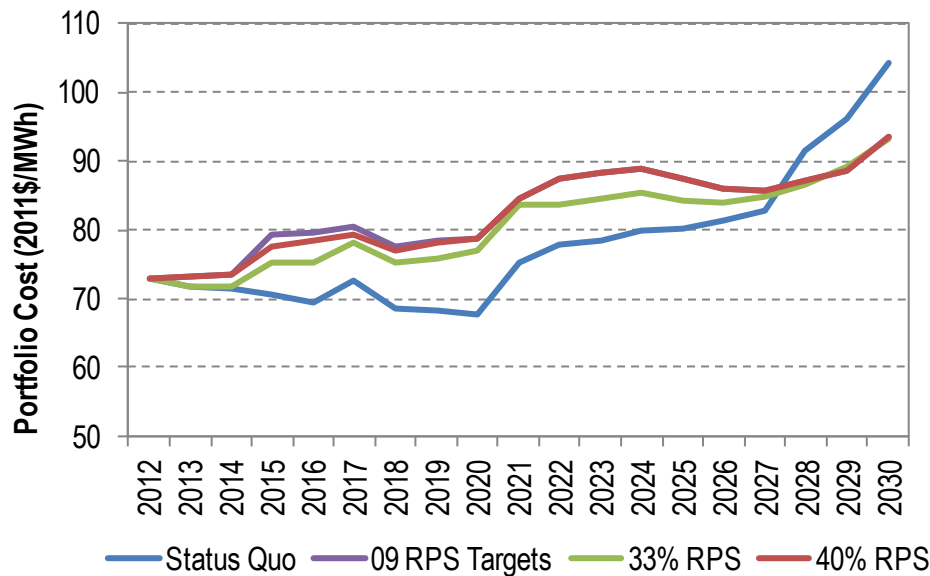
- PWP’s load forecast has been reduced due to the economic recession as well as expectations for efficiency and demand side management penetration. Reduced demand results in lower renewable energy procurement requirements for RPS compliance.
- The biogas contracts represent a significant new source of RPS-compliant generation.
- The relative costs of new renewable contract options have changed in line with the most recent quotes received by PWP.

Exhibit 15 summarizes the annual cost projections for each portfolio over time under Reference Case market conditions. Although California’s AB 32 greenhouse gas emission reduction law is expected to increase the costs of fossil-based generation in 2013, PWP’s free allocation of credits is likely to keep portfolio costs relatively stable in real dollars in the near term. The RPS portfolios diverge from the status quo after 2014 due to the addition of renewable resources, a natural gas-fired combined cycle, and 5 MW of demand response. In addition to the base 33% and 40% RPS portfolios, Pace Global has assessed

the incremental costs associated with hitting the RPS targets as specified in the 2009 IRP (33% in 2015 and 40% in 2020). This portfolio option, *which is different than the 2009 IRP plan and designated as “09 RPS Targets”* in Exhibit 15, has an incremental cost increase of one to two dollars per MWh above the 40% RPS portfolio between 2015 and 2020.

All portfolios increase in cost slightly in 2021 due to the expectation that a federal carbon policy will have a less favorable free allocation mechanism than the plan for AB 32. Beyond 2027, the IPP coal contract expires, raising costs for all portfolios. The costs of the status quo portfolio are expected to rise significantly in the late 2020s due to market energy, capacity, and REC compliance purchases to meet energy needs, reserve margin requirements, and RPS compliance, respectively. Since the Status Quo portfolio does not meet RPS requirements with physical contracts, a \$50/MWh alternative compliance payment is assessed in Pace Global’s analysis for all shortfalls.

**Exhibit 15: Portfolio Costs over Time – Reference Case Market Conditions (2011\$/MWh)**



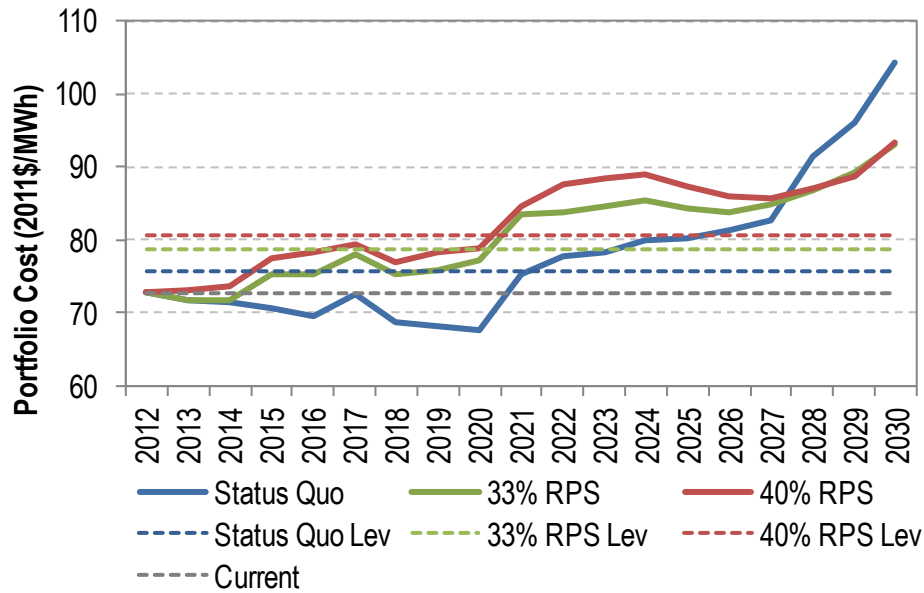
Source: Pace Global

Exhibit 16 summarizes the levelized cost impacts for each of the portfolio options. The levelized cost is a measure of the average costs of each portfolio over a specified time period, taking into account PWP’s discount rate. It should be noted that the levelized value calculation incorporates the entire forecast period, with the 33% RPS portfolio having a four percent higher levelized cost than the status quo. Extending the RPS compliance to 40% raises the costs an additional two percent on a levelized basis.

Exhibit 17 summarizes the expectations for cost differences across various time periods for each of the portfolio options versus the status quo, while Exhibit 3 (above) summarizes the expected bill impacts for PWP customers. Although costs are expected to be relatively stable in real terms over the next few years, over the 2013-2017 time period, the 33% RPS portfolio is projected to be four percent higher than the status quo in real terms, with a seven percent expected increase over a ten year time period. The 40% RPS portfolio is expected to have an incremental two to three percent cost impact above the 33% RPS portfolio. If PWP were to accelerate the 33% RPS compliance to 2015, an additional one percent cost impact over the 2013-2017 time period would be expected (results of this portfolio are shown in the shaded column).

Under these projected increases, a residential customer consuming an average of 500 kWh per month would be expected to face a one to two dollar monthly bill increase (*in real dollars*) associated with the 33% RPS portfolio and expected changes in market conditions over the next two to ten years. An additional one dollar increase is associated with moving to a 40% RPS portfolio.

**Exhibit 16: Levelized Portfolio Cost Expectation (2011\$/MWh)**



Source: Pace Global

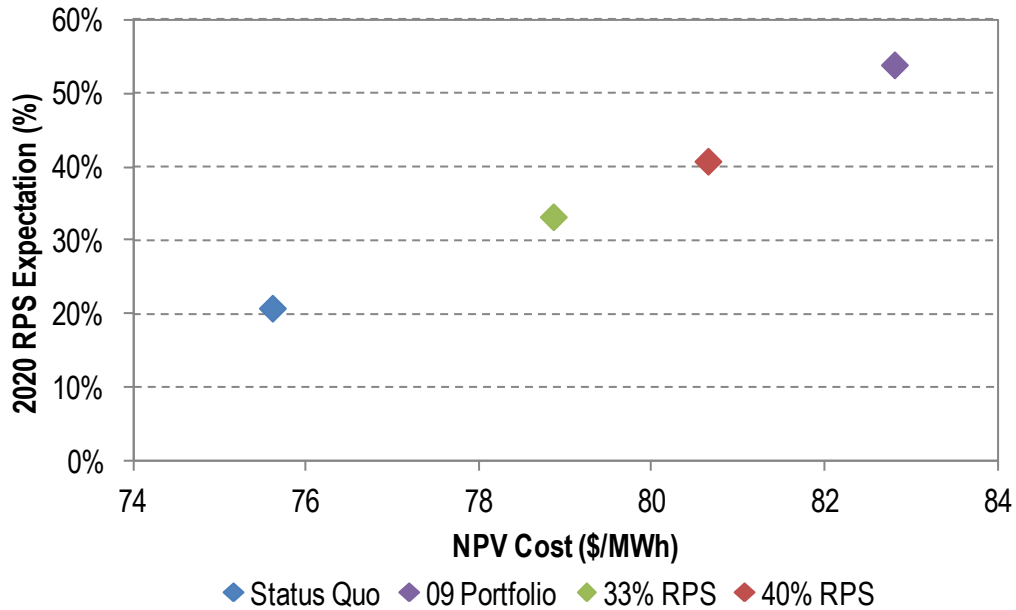
**Exhibit 17: Reference Case Portfolio Cost Differences across Various Study Periods**

Time Period	33% RPS vs. Status Quo	40% RPS vs. Status Quo	33% in 2015/40% in 2020 vs. Status Quo
2013-2017	4.3%	7.0%	8.1%
2013-2022	7.0%	9.8%	10.6%
2013-2030	4.7%	7.3%	7.7%

Source: Pace Global

On a levelized cost basis, each additional 1% increase in renewable share by 2020 is associated with a \$0.22/MWh (\$0.00022/kWh) increase in total levelized portfolio costs. This relationship is shown in Exhibit 18.

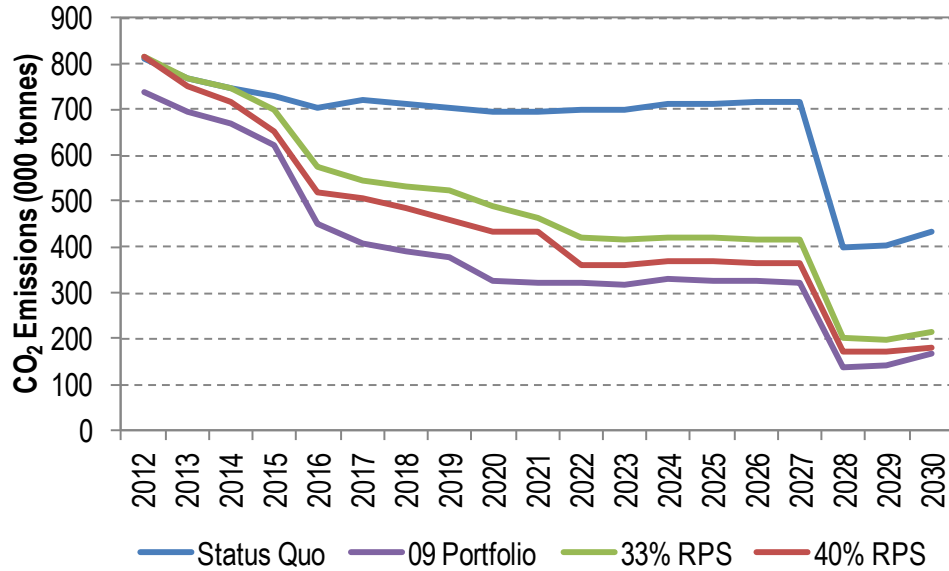
**Exhibit 18: 2020 RPS Expectation vs. Levelized Portfolio Cost**



Source: Pace Global

CO<sub>2</sub> emissions reductions are highly correlated to the percentage of renewable resources within the portfolios. The preferred plan and the 40% RPS result in the largest declines, while the 33% RPS portfolio achieves reductions still in line with AB 32 targets. The status quo portfolio results in a relatively stable emissions profile over time because even as renewable contracts expire, load requirements slightly decline. All portfolios see a significant drop in 2028 after the expiration of the IPP coal contract. Exhibit 19 displays the annual emission reductions over time under Reference Case market conditions.

**Exhibit 19: CO<sub>2</sub> Emissions across Portfolios – Reference Case Market Conditions**



Source: Pace Global

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## MARKETLINK SCENARIOS AND PORTFOLIO RISK ANALYSIS

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### OVERVIEW

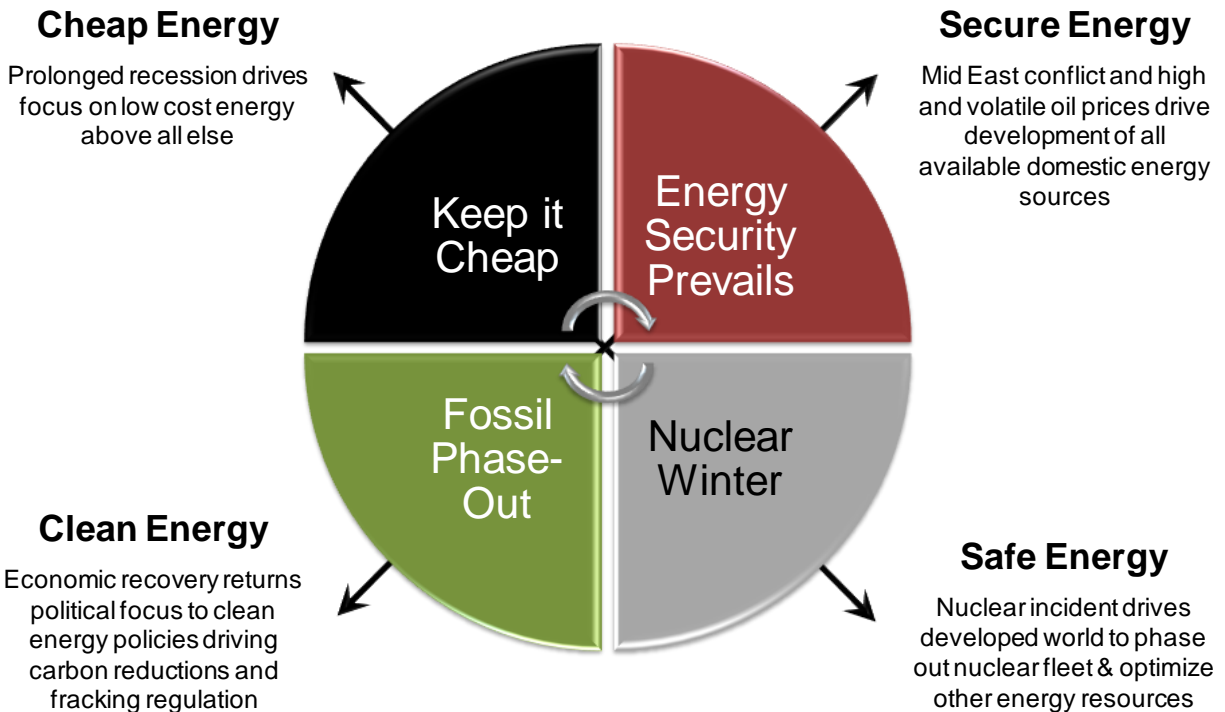
Pace Global has deployed its MarketLink scenarios to assess the uncertainty and risk profile of each of the portfolios developed for this analysis. In addition to a Reference Case grounded in current market forwards and Pace Global’s reference market driver expectations going forward, the MarketLink scenarios offer four internally consistent states-of-the-world that are developed against a backdrop of changing policy frameworks over time. The scenarios are developed around the prevalence of one of several competing themes for energy market dynamics in the United States and throughout the world:

- Cheap energy: A primary focus on low cost energy sources above other objectives like environmental protection or energy security.
- Clean energy: A primary focus on regulatory policy that aims to reduce carbon emissions and limit the environmental risks associated with domestic natural gas production.
- Secure energy: A primary focus on development of domestic energy supply.
- Safe energy: An opposition to nuclear energy and a shift to other resources in electricity production.

Exhibit 20 summarizes the major themes associated with each of these scenarios.

**Exhibit 20: Summary of MarketLink Scenario Themes**

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Source: Pace Global

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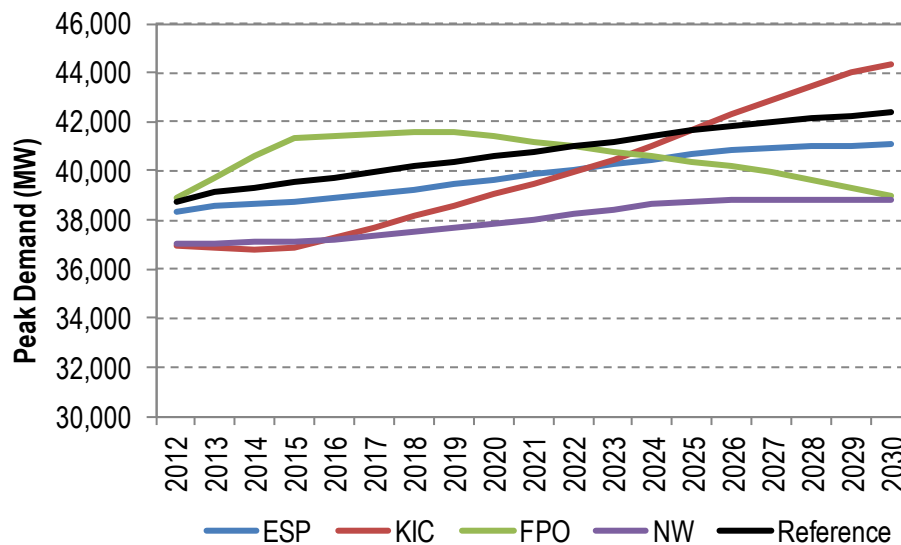
Pace Global has customized these market scenarios in order to develop meaningful ranges of key market drivers relevant to PWP's portfolio analysis. Key drivers include regional and PWP electric load growth, natural gas prices, and CO<sub>2</sub> compliance costs.

## REGIONAL LOAD GROWTH

Load growth projections are developed based on two major factors: economic growth and expected penetration of energy efficiency and demand side management initiatives. The following summarizes the key drivers in load growth expectations over time for each scenario, while Exhibit 21 displays the details for peak load throughout the CAISO's Southern California zone, which is representative of the entire region within the SP15 pricing zone:

- **Keep It Cheap:** Double-dip recession keeps economic growth and load growth weak in the near term. Longer-term focus on economic growth de-emphasizes efficiency deployment.
- **Fossil Phase-Out:** Economic recovery results in load recovery in the near term. Longer-term emphasis on environmental objectives results in strongest penetration of demand side and efficiency measures and declining load.
- **Energy Security Prevails:** Global energy crisis hampers economic growth slightly in the short term, with modest growth throughout the Study Period.
- **Nuclear Winter:** Aggressive load reduction policies lead to lowest growth rate projections across all cases.

**Exhibit 21: Summary of Southern CA Peak Load Projections across MarketLink Scenarios**



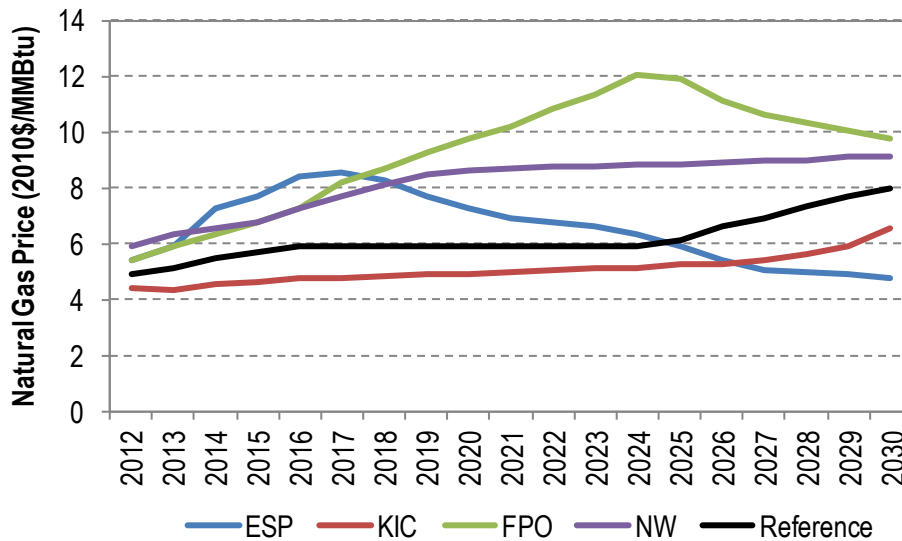
Source: Pace Global

## NATURAL GAS PRICES

Natural gas price projections are developed according to primary supply and demand drivers that influence domestic production costs as well as international market dynamics. The following summarizes the key drivers in price expectations over time for each scenario, while Exhibit 22 displays the details:

- Keep It Cheap: Double-dip recession keeps demand and prices low for several years. Robust demand growth in the outer years contributes to increasing natural gas prices.
- Fossil Phase-Out: Economic recovery and carbon policy at the state and federal levels drives towards increased domestic demand in the power sector (to replace coal-fired generation) and elevated pricing. Environmental restrictions on fracking and shale gas production leads to additional cost pressures and highest long term price outlook.
- Energy Security Prevails: Global energy crisis results in a spike in natural gas prices in the near term. As non-fossil technology developments are made and as political support (and subsidies) for domestic natural gas production increases, natural gas prices fall over time.
- Nuclear Winter: Loss of major baseload electricity production increases demand for natural gas for power generation and contributes to steadily increasing prices.

**Exhibit 22: Summary of Henry Hub Natural Gas Price Projections across MarketLink Scenarios**



Source: Pace Global

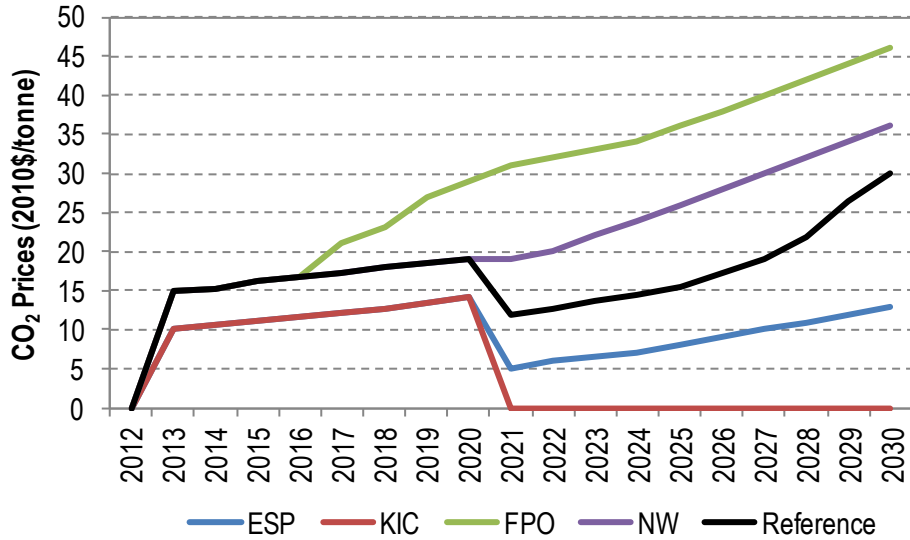
**CO<sub>2</sub> PRICES**

CO<sub>2</sub> price projections are developed according to expectations for both state and federal policy and regulations. The following summarizes the key drivers in price expectations over time for each scenario, while Exhibit 23 displays the details:

- Keep It Cheap: Political support for greenhouse gas regulation wanes over time with no federal policy enacted and a phase-out of California’s current program after 2020.
- Fossil Phase-Out: Strong federal policy pre-empts California state regulations after 2015, with prices rising close to \$50/tonne by 2030.
- Energy Security Prevails: California policy is replaced by a modest federal program after 2020, with prices below \$20/tonne throughout the Study Period.
- Nuclear Winter: Emphasis on safe supply results in pressure on nuclear and coal fleets. In the face of federal CO<sub>2</sub> reduction targets, prices climb above \$30/tonne.



**Exhibit 23: Summary of CO<sub>2</sub> Price Projections across MarketLink Scenarios**

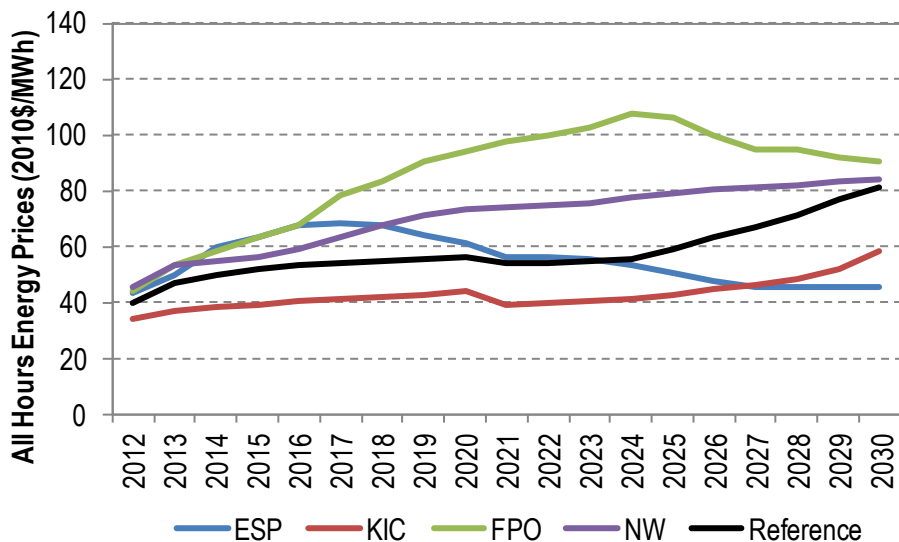


Source: Pace Global

## CALIFORNIA SOUTH POWER PRICES

Power price projections are developed through Pace Global's regional dispatch modeling system and take into account each of the key drivers discussed above. Regional capacity expansion and retirements are assessed based on proposed project economics and the regulatory regime assumed across each of the MarketLink scenarios. Exhibit 24 summarizes the range of market power price projections.

**Exhibit 24: Summary of SP-15 All Hours Power Price Projections across MarketLink Scenarios**

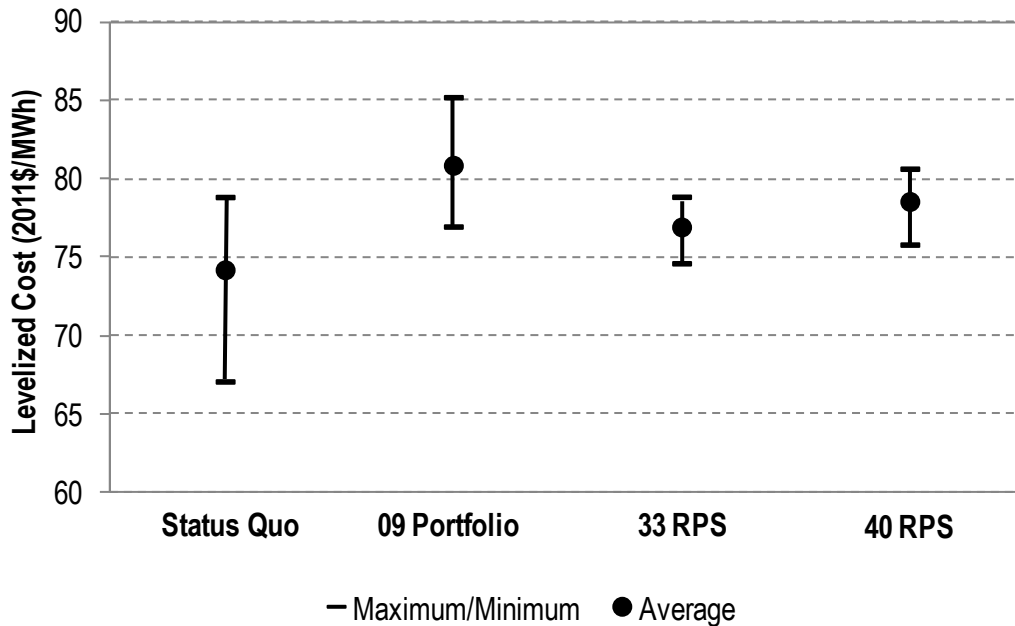


Source: Pace Global

## PORTFOLIO RISK ANALYSIS

Exposing each of the four portfolios to the MarketLink scenarios summarizes the relative risk profile of each of the strategies. Assuming the renewable price tiers used in the analysis are generally representative of the expected cost profile of renewables over the Study Period, the uncertainty in natural gas prices and CO<sub>2</sub> compliance costs results in significant uncertainty for the status quo portfolio. This is because the portfolio is highly dependent on fossil-fired generation and market purchases, which are subject to market volatility in natural gas prices, CO<sub>2</sub> compliance costs, and CAISO power market prices. In fact, given assumed renewable costs, the higher RPS portfolios have less uncertainty overall. This conclusion, however, is highly dependent on uncertainty in renewable procurement costs. The range of uncertainty for each portfolio across the various scenarios is displayed in Exhibit 25 and Exhibit 26.

**Exhibit 25: Range of Levelized Portfolio Costs across MarketLink Scenarios**



Source: Pace Global

**Exhibit 26: Levelized Portfolio Costs for All MarketLink Scenarios (2011\$/MWh)**

Scenario	Status Quo	09 Portfolio	33% Portfolio	40% Portfolio
Cheap	67.08	85.21	77.82	80.62
Clean	78.84	76.96	76.54	76.67
Secure	71.55	81.75	76.82	79.05
Safe	77.93	77.60	74.62	75.81
Reference	75.61	82.80	78.86	80.65

Source: Pace Global

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## APPENDIX I: RENEWABLE CONTRACT PRICE INPUTS

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### PWP RENEWABLE CONTRACT OFFERS USED FOR COST ESTIMATES

As specified in Exhibit 7, Pace Global developed renewable energy costs based on current renewable contract offers in front of PWP. The following representative pricing points summarize the base parameters (in nominal \$) used in Pace Global’s Tier I estimates:

- LFG: \$105.25/MWh, 0% escalation
- Biomass: \$117/MWh first 10 years, \$74/MWh plus 1.5% escalation years 11+
- Geothermal: \$73.40/MWh, escalated with inflation
- Solar: \$96.85/MWh, 1.5% escalation
- Wind: \$86.86/MWh, 1.5% escalation

### INFLATION RATE

Exhibit 27 shows the annual deflator series Pace Global uses for conversion of nominal contract terms into real dollars. Pace Global uses the market rate implied by the yield on treasury bonds and similar maturity Treasury Inflation Protected Securities (“TIPS”). The yield quoted on treasury bonds is equal to the real yield plus inflation, while the yield quoted for TIPS is the real yield. Subtracting the yield of TIPS from the yield of Treasury bonds arrives at the market’s forward implied inflation rate. Beyond the time period of available data, Pace uses a general inflation rate of 2.0%.

#### Exhibit 27: Pace Global Annual Deflator Series

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Year	Deflator to 2011\$
2012	1.012
2013	1.027
2014	1.045
2015	1.063
2016	1.083
2017	1.103
2018	1.125
2019	1.148
2020	1.171
2021	1.194
2022	1.218
2023	1.242
2024	1.267
2025	1.292
2026	1.318
2027	1.345
2028	1.371
2029	1.399
2030	1.427

Source: Pace Global and implied rate from U.S. Treasury Inflation Protected Series

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## APPENDIX II: PWP SURVEY & RESULTS

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### CUSTOMER SURVEY

PWP conducted a survey to gauge the willingness of customers to pay higher rates for a higher renewable generation in the portfolio. Exhibit 28 is a reproduction of PWP's Customer Survey on Energy Resources ("the survey") given to electric customers via bills, online accounts, and a variety of local public events.

#### Exhibit 28: PWP Customer Survey

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*In 2009, a 20-year energy resources plan was adopted by the City of Pasadena, and a review of this plan is underway. The 2009 plan targeted a goal of 40% renewable energy content by 2020, and this survey will help us update the community's desire to achieve this goal.*

*Renewable resources such as wind, solar geothermal and biomass are better for the environment than conventional energy (natural gas, nuclear, coal, etc.) but currently cost more. The State of California requires that all electric utilities get 33% of its energy supply from renewable resources by 2020. Pasadena Water & Power (PWP) current gets about 15% of its energy from renewable sources.*

1. Would you be willing to pay a higher electric rate in order to get 33% of your energy from renewable resources?

NO.  
 Yes, I would pay a rate increase of:  
\_\_\_ 5% \_\_\_ 10% \_\_\_ 15% \_\_\_ 20%  
\_\_\_ Other (\_\_\_\_\_)

2. Once PWP has met the state's 33% renewables mandate, would you be willing to pay more to help PWP meet its own goal of 40% renewables?

NO.  
 Yes, I would pay a rate increase of:  
\_\_\_ 5% \_\_\_ 10% \_\_\_ 15% \_\_\_ 20%  
\_\_\_ Other (\_\_\_\_\_)

3. Do you live in or own a business in Pasadena?

Live  Own Business  Both

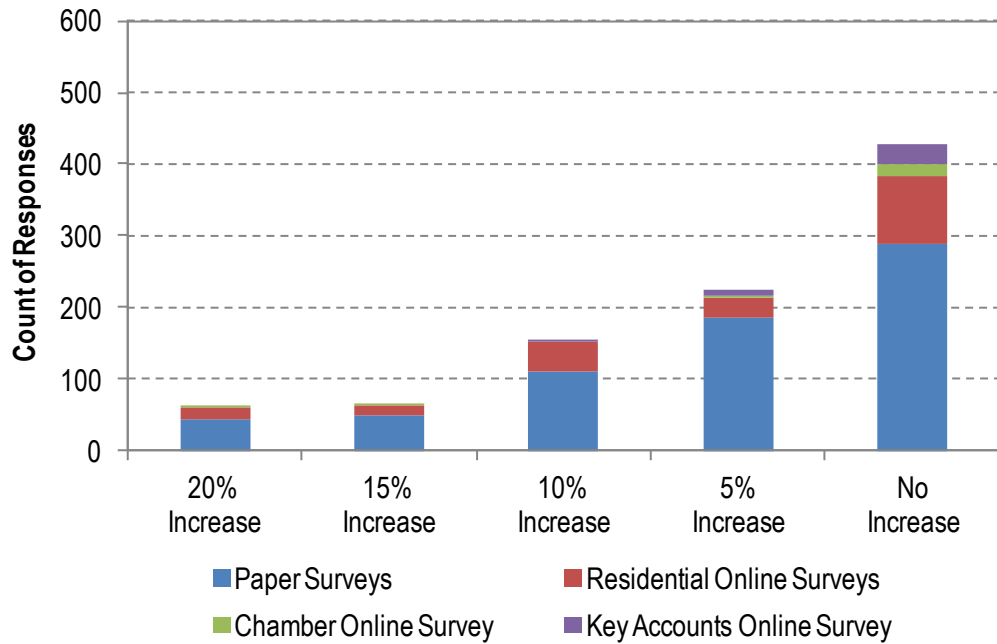
Note: One version of the survey had both an additional option (25%) for Question 2 and an abridged introduction.  
Source: PWP

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## SURVEY RESULTS

Exhibit 29 shows the results for Question 1 of the survey, which sought information about what rate increase customers would be willing to pay to facilitate PWP in reaching the state mandated 33% RPS goal. Each response category is broken up to highlight the means by which the survey was taken. Exhibit 30 shows the proportion of customers who indicated which rate change they would be willing to pay; the results suggest that the majority (70%) of those surveyed do not wish to see more than a 5% increase in their bills.

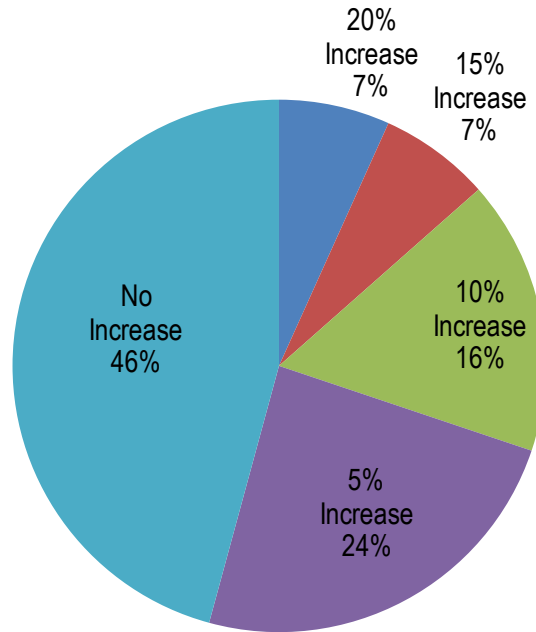
**Exhibit 29: PWP Customer Survey Question 1 Categorical Results**



Source: PWP and Pace Global

**Exhibit 30: PWP Customer Survey Question 1 Results Summary**

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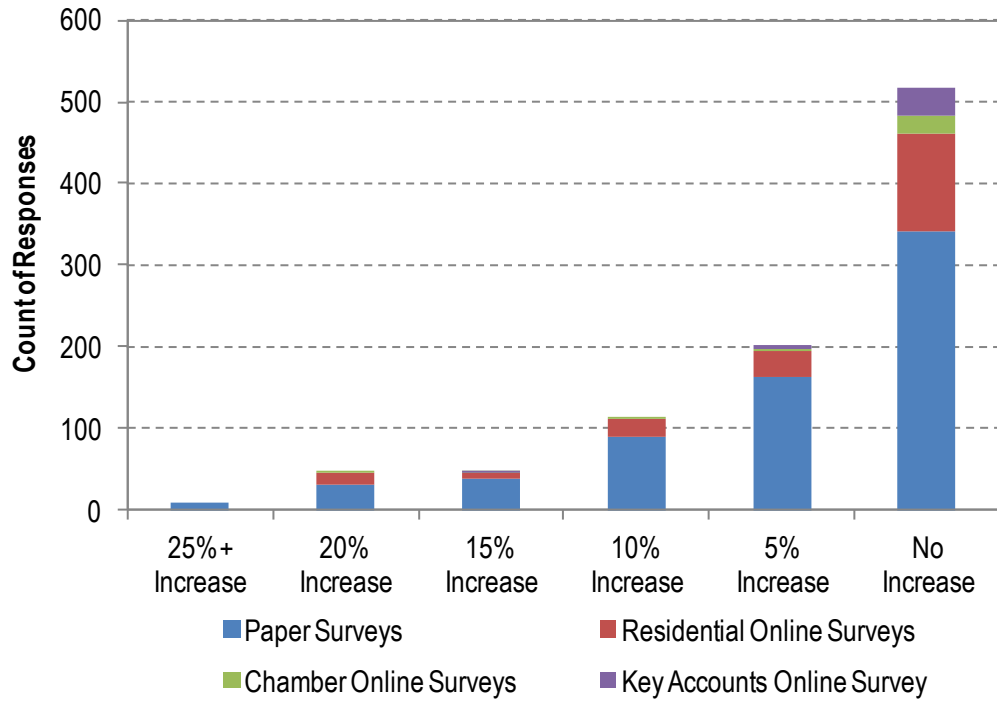


Source: PWP and Pace Global

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Exhibit 31 shows the results for Question 2 of the survey, which sought information about what rate increase customers would be willing to pay to facilitate PWP in reaching their own 40% renewable goal. The details of this goal were laid out in the utility's 2009 IRP. Each response category is broken up to highlight the means by which the survey was taken. Exhibit 32 shows the proportion of customers who indicated which rate change they would be willing to pay; the results again suggest that the majority (77%) of those surveyed do not wish to see more than a 5% increase in their bills.

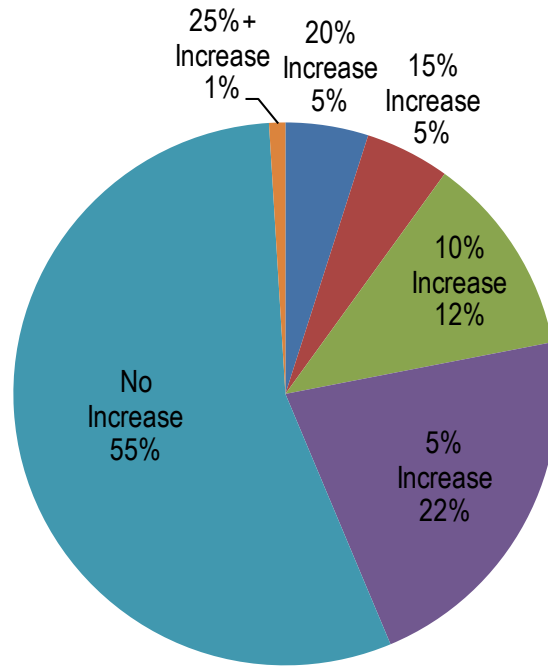
**Exhibit 31: PWP Customer Survey Question 2 Categorical Results**



Source: PWP and Pace Global

**Exhibit 32: PWP Customer Survey Question 2 Results Summary**

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Source: PWP and Pace Global

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