

# Designing Performance Based Incentives: Preliminary Results

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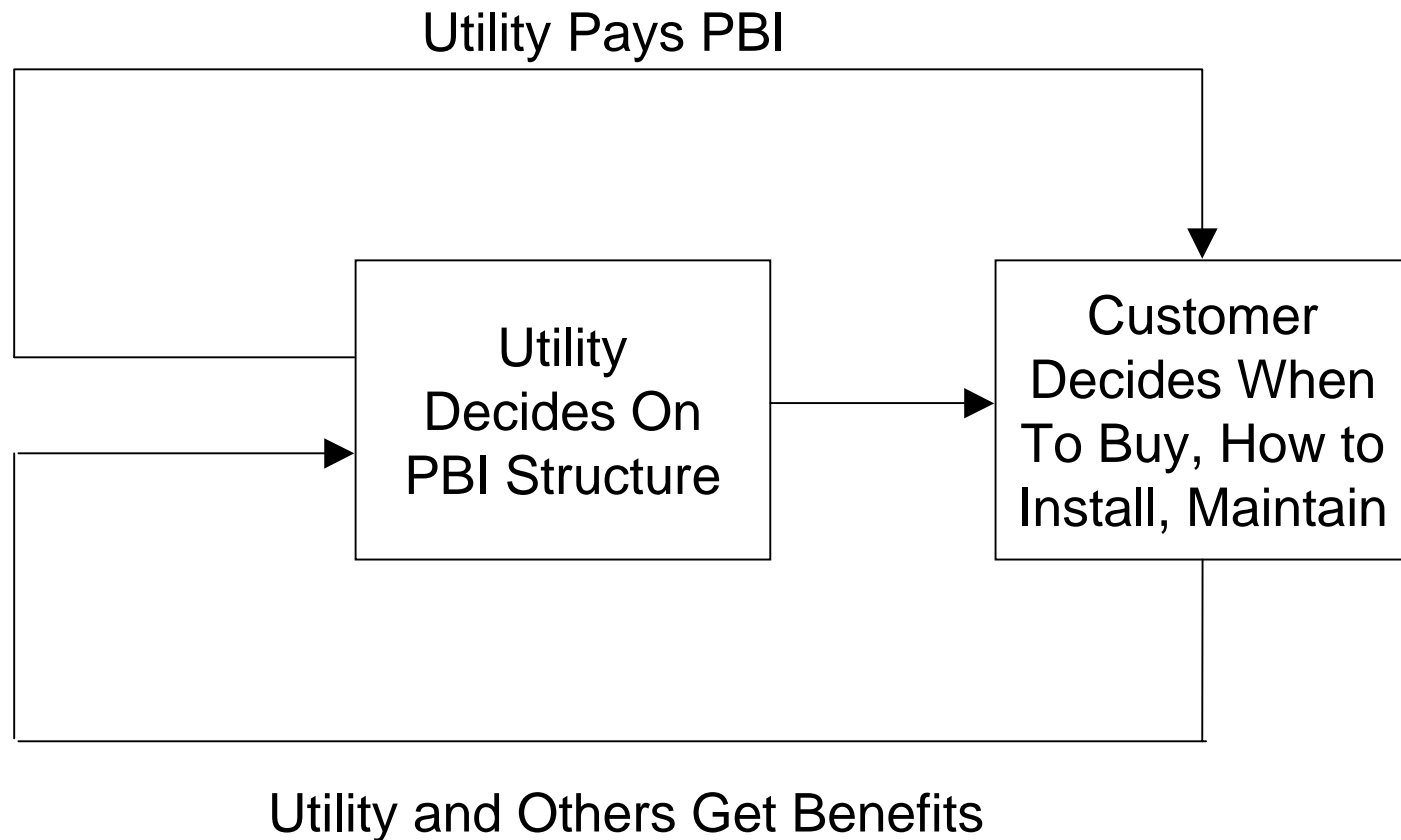
California PV Utility Program Managers Meeting

February 1, 2006, San Diego, CA

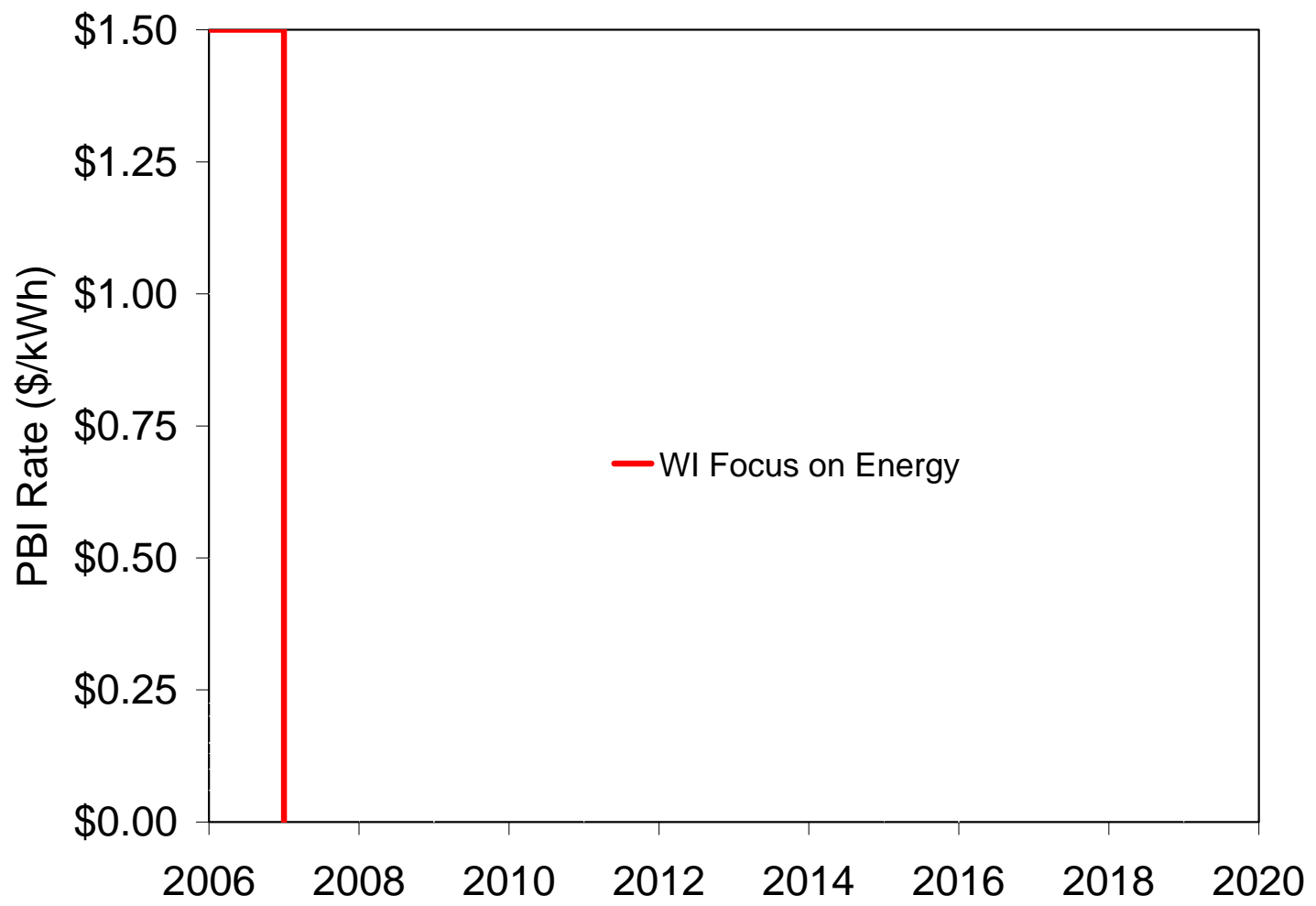
# Acknowledgements

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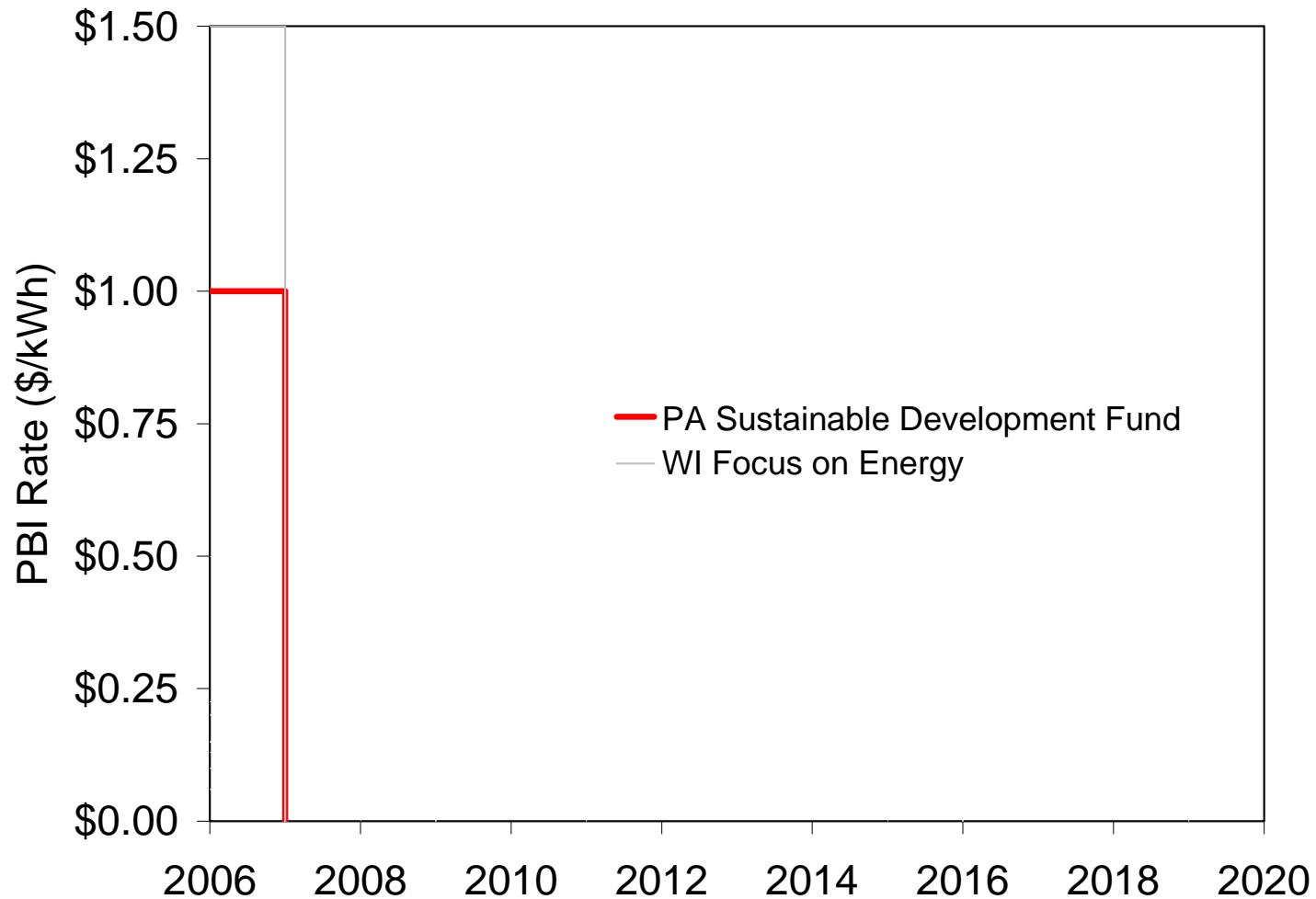
# How Do Performance Based Incentives Work?



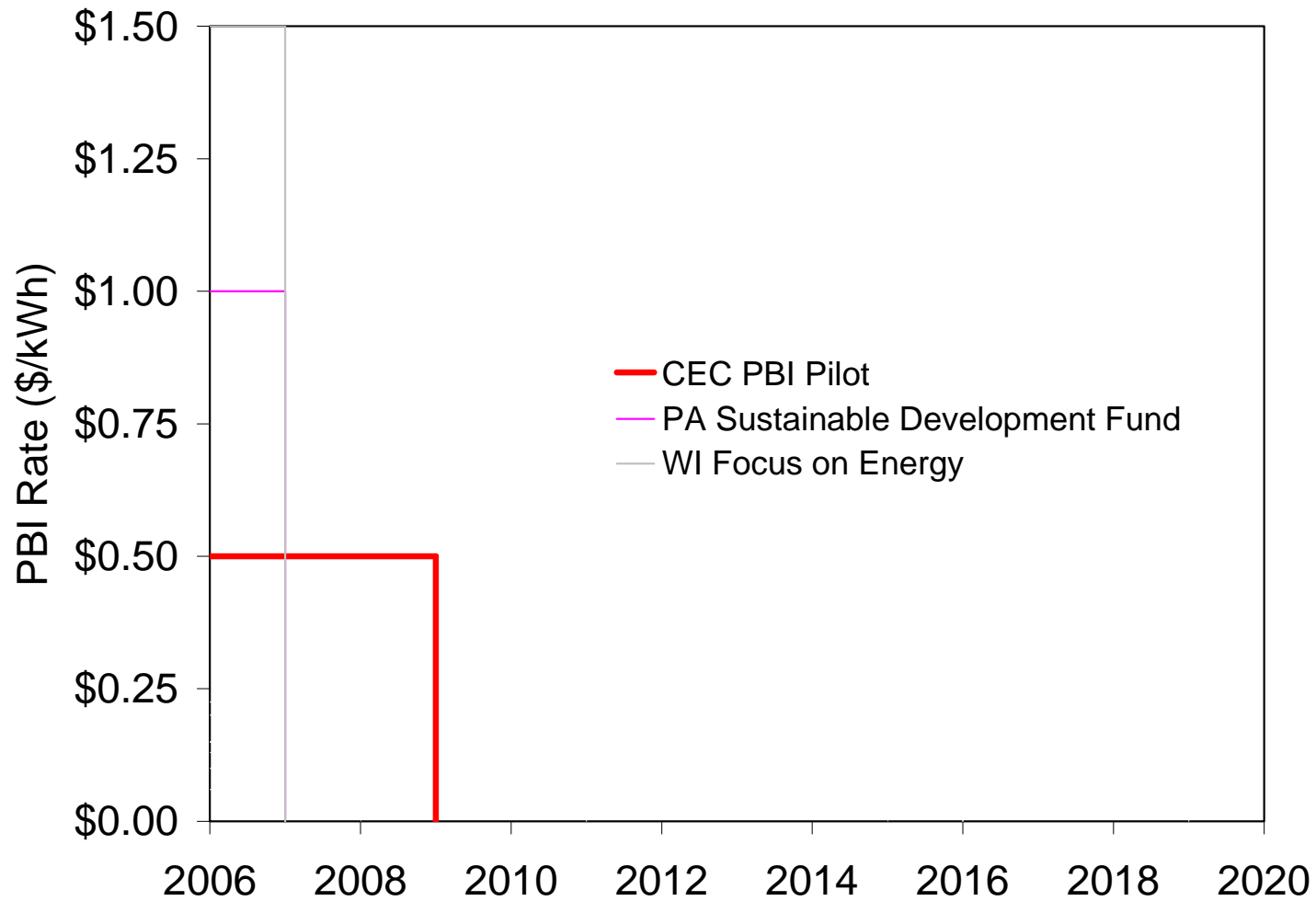
# WI Focus on Energy



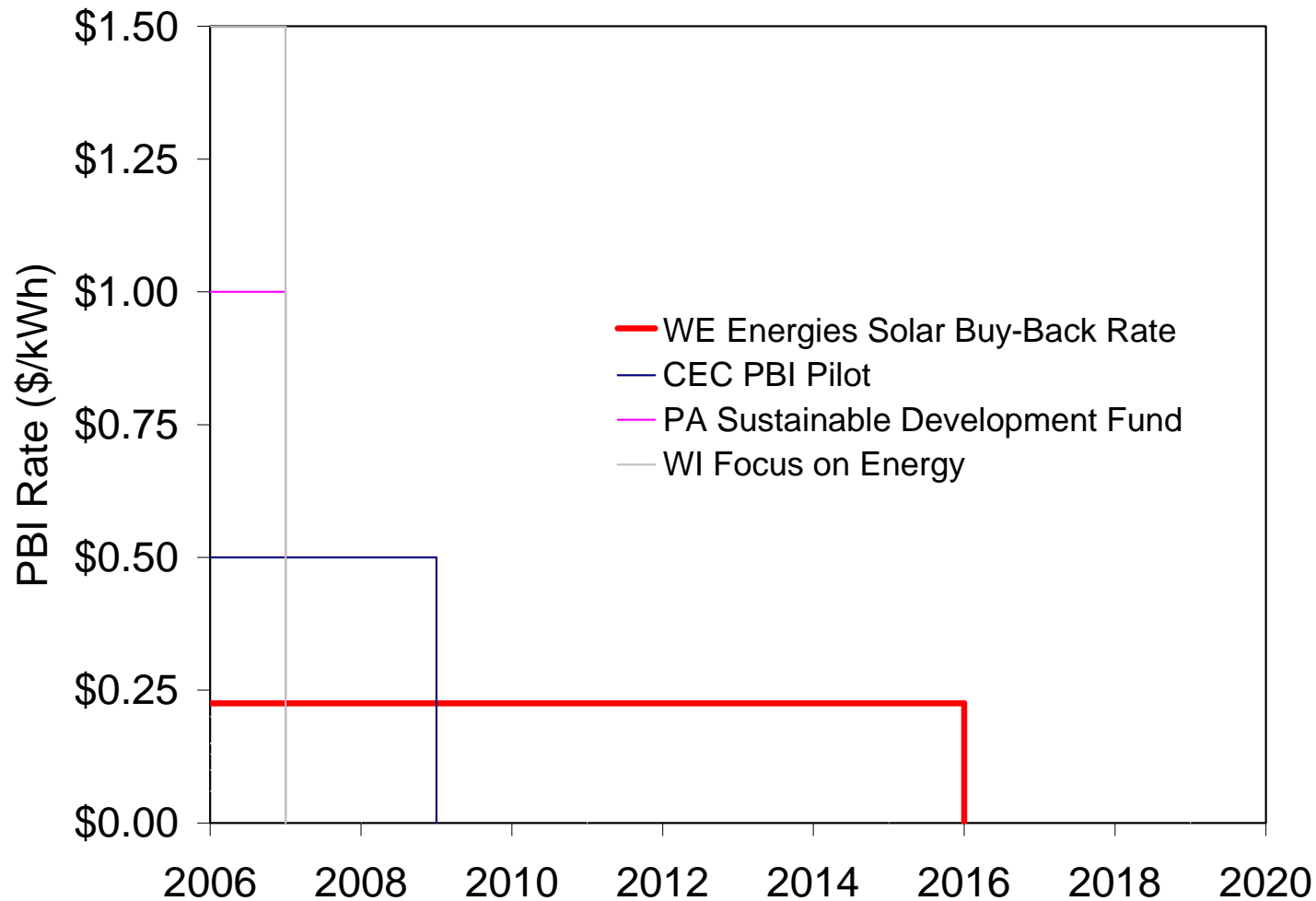
# PA Sustainable Development Fund



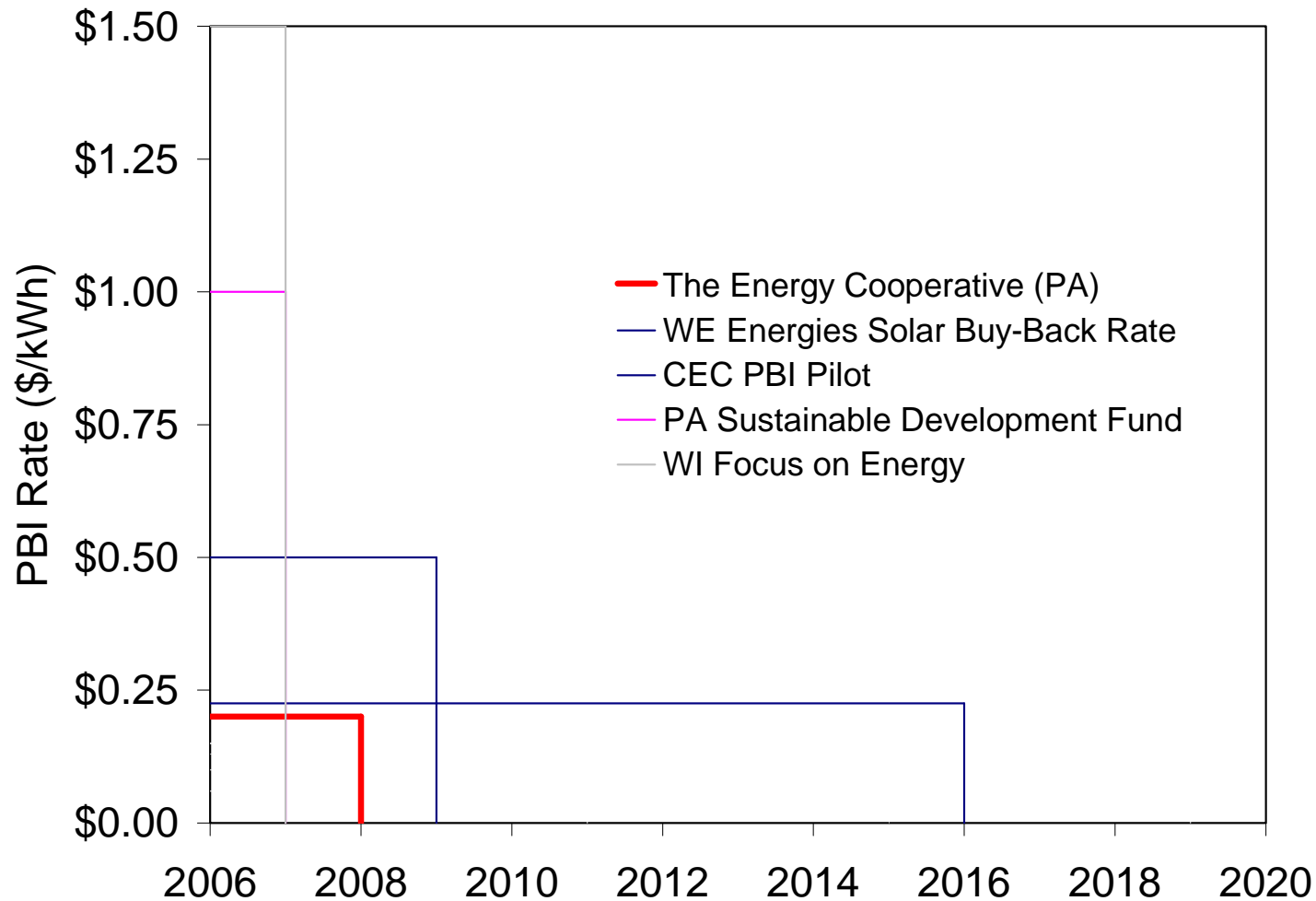
# CEC PBI Pilot



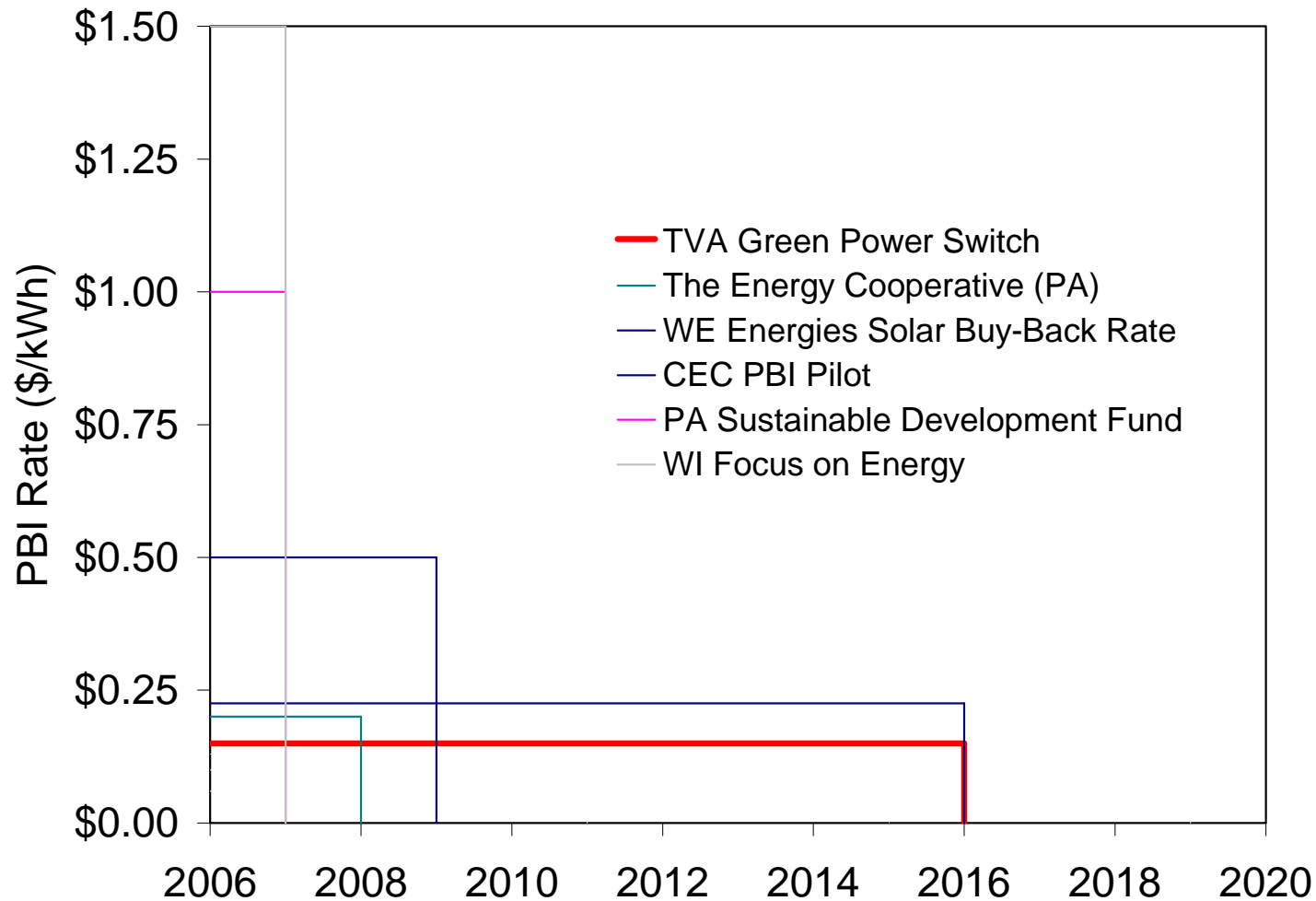
# WE Energies Solar Buy-Back Rate



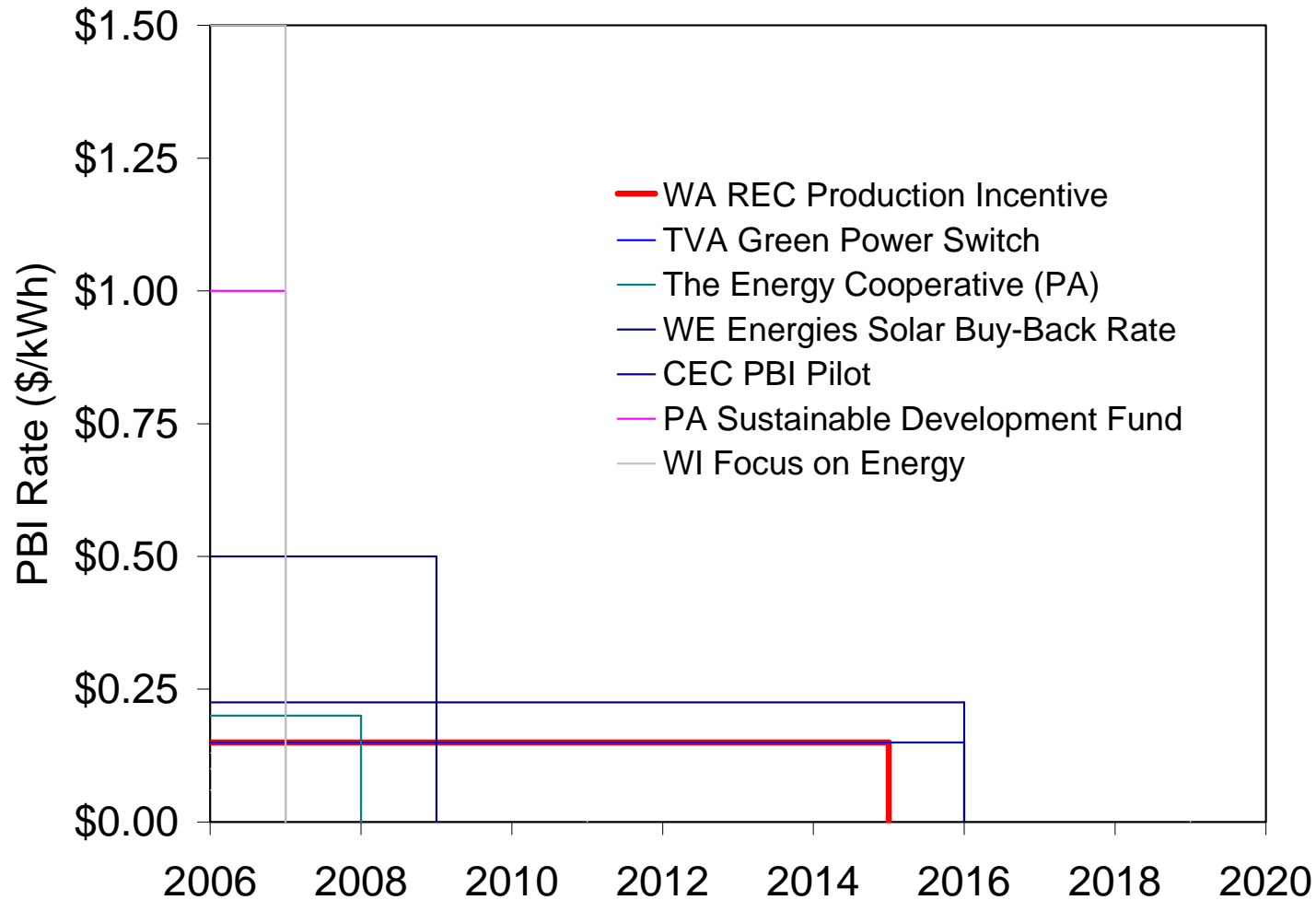
# The Energy Cooperative (PA)



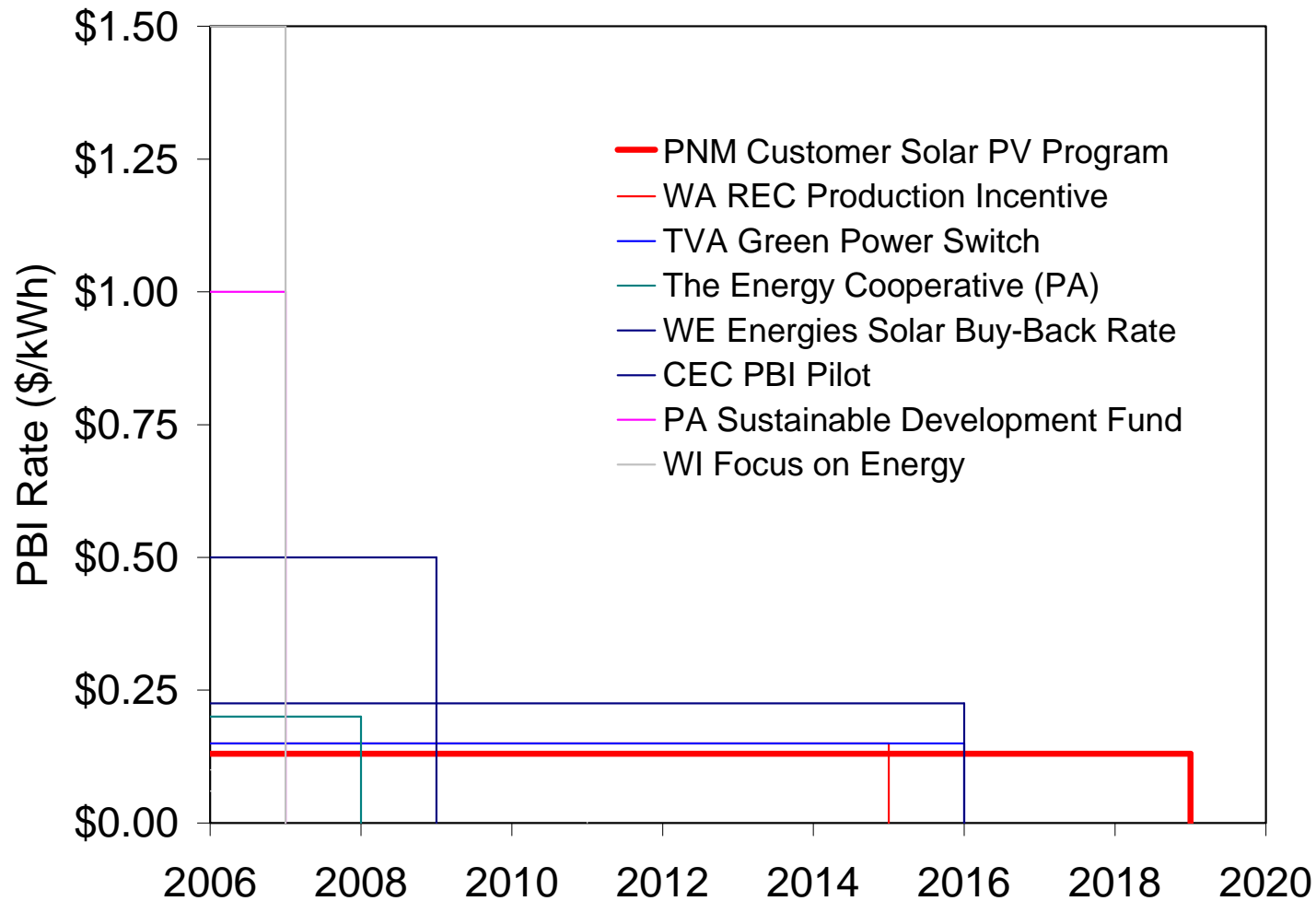
# TVA Green Power Switch



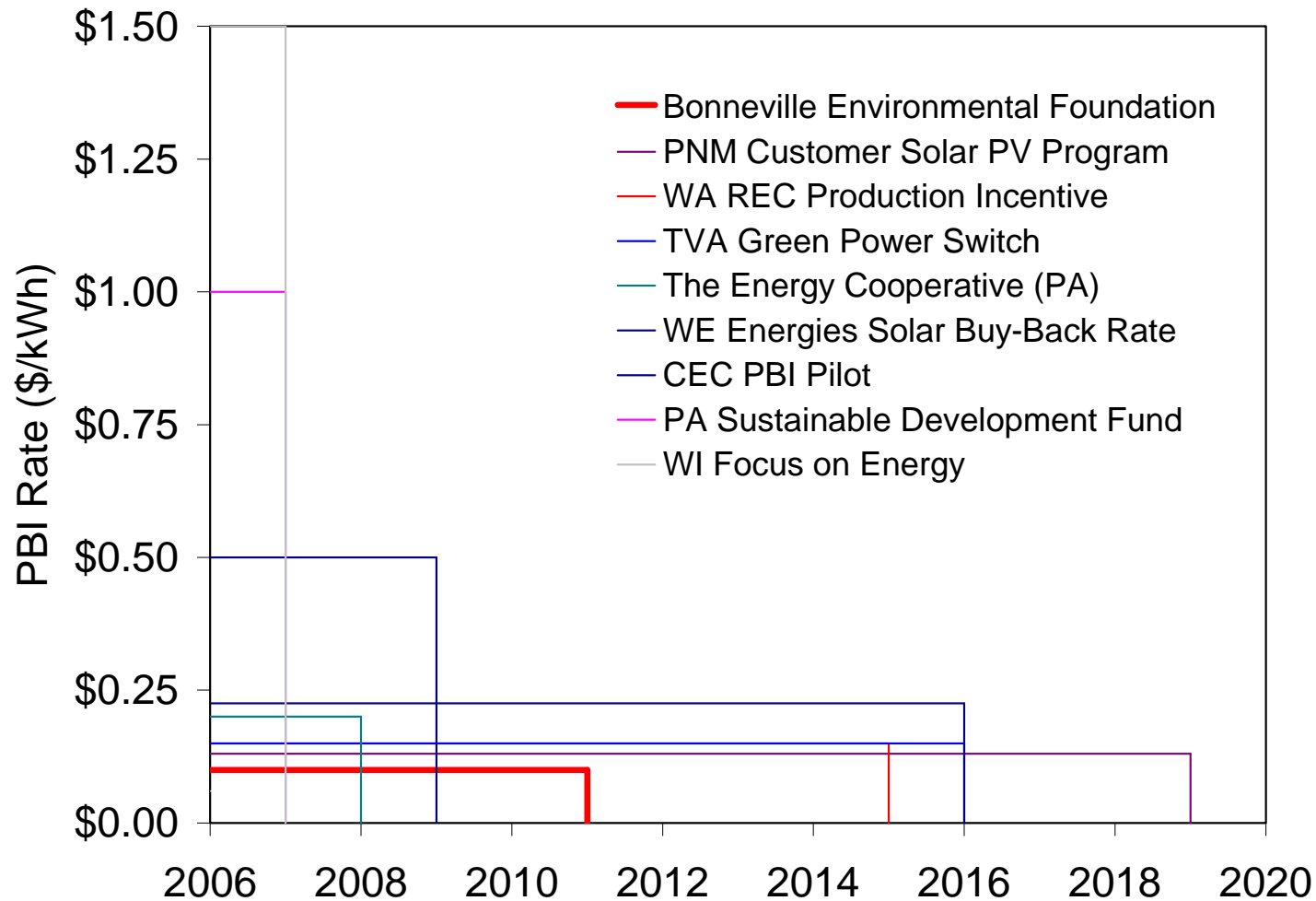
# WA REC Production Incentive



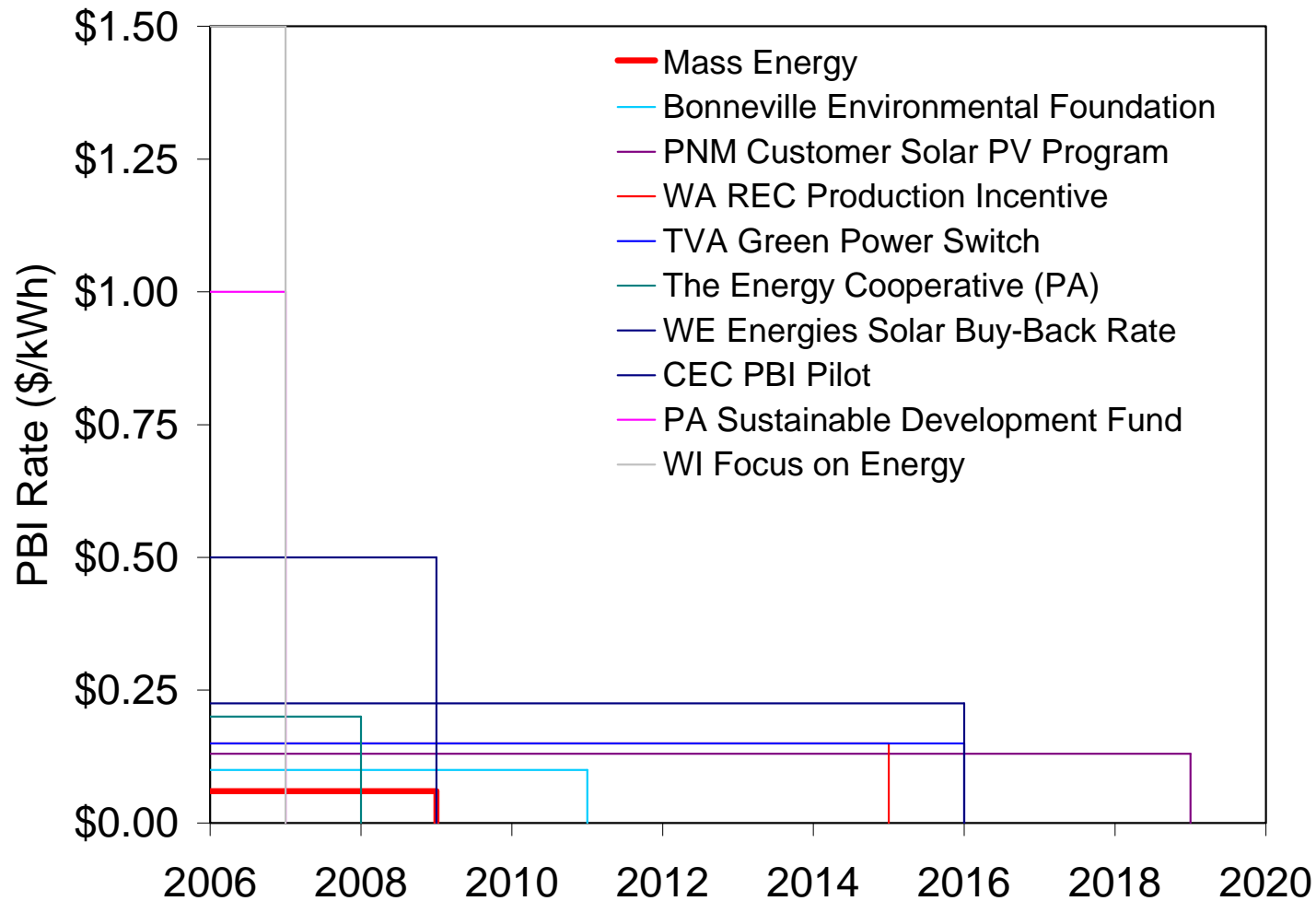
# PNM Customer Solar PV Program



# Bonneville Environmental Foundation



# Mass Energy



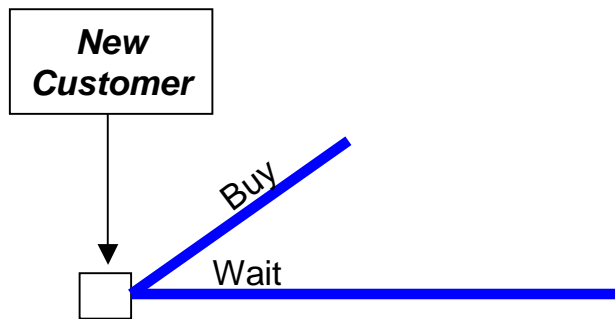
## Outstanding Questions

- What should the PBI rate be?
- What should the PBI duration be?
- Should PBI rate be constant or vary?
- How should structure change over time?
- Should structure be customer-specific?
- Should PBI structure vary geographically?

## Two Key Perspectives

- Utility: How should the PBI be structured?
- Customer: Whether or not to buy, how to install and maintain?

# Customer Decision: To Buy or Not To Buy



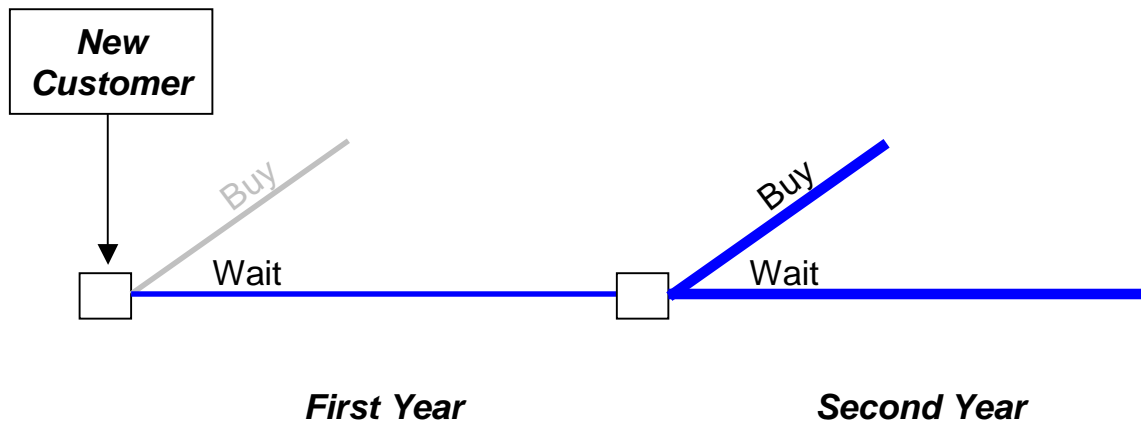
*First Year*

*Second Year*

*Third Year*

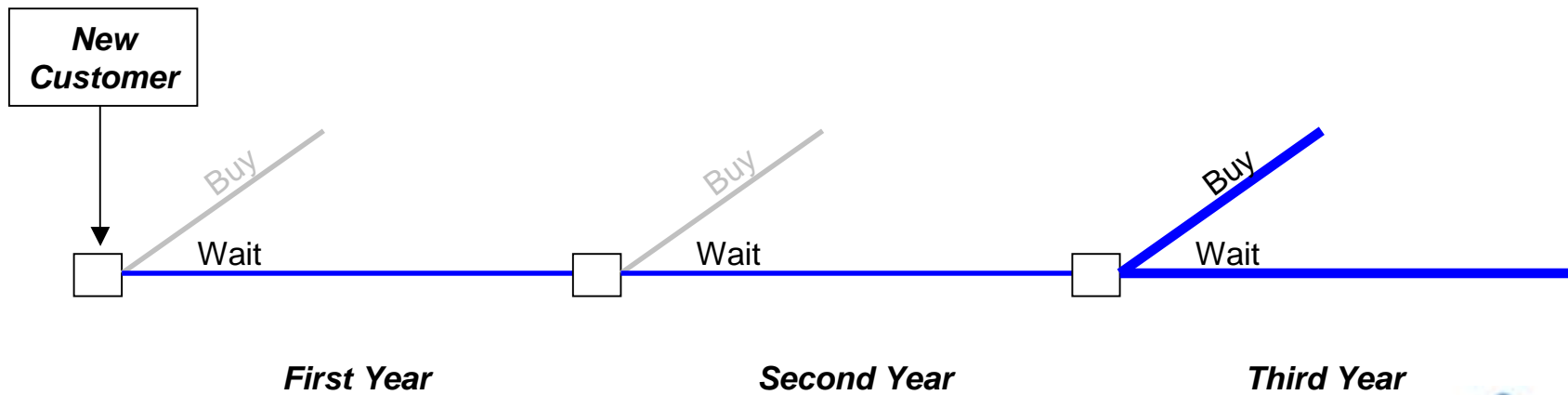
□ = decision    ○ = uncertainty

# If Customer Waits, Same Decision Next Year



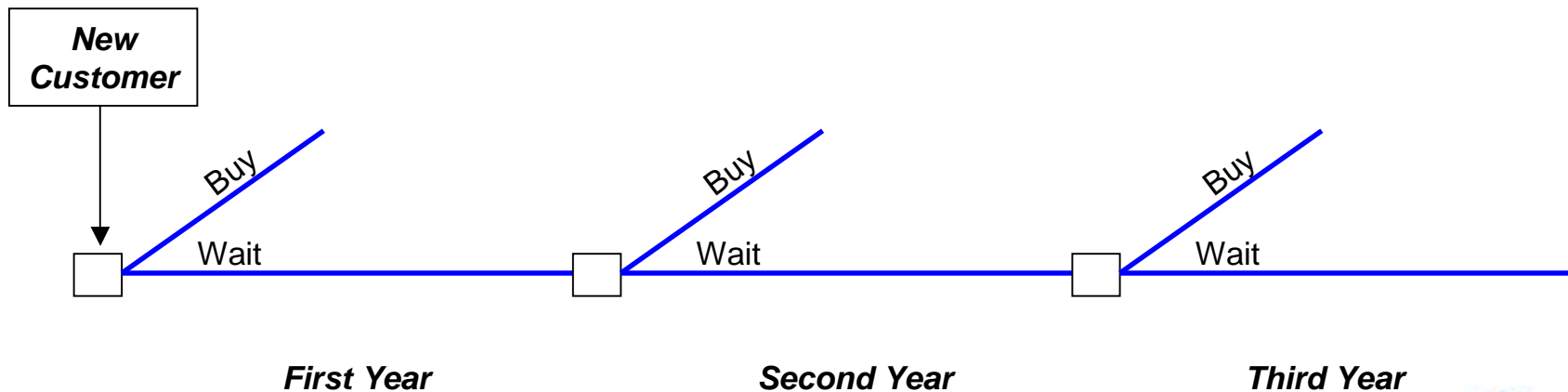
□ = decision    ○ = uncertainty

# ... And The Next Year ...



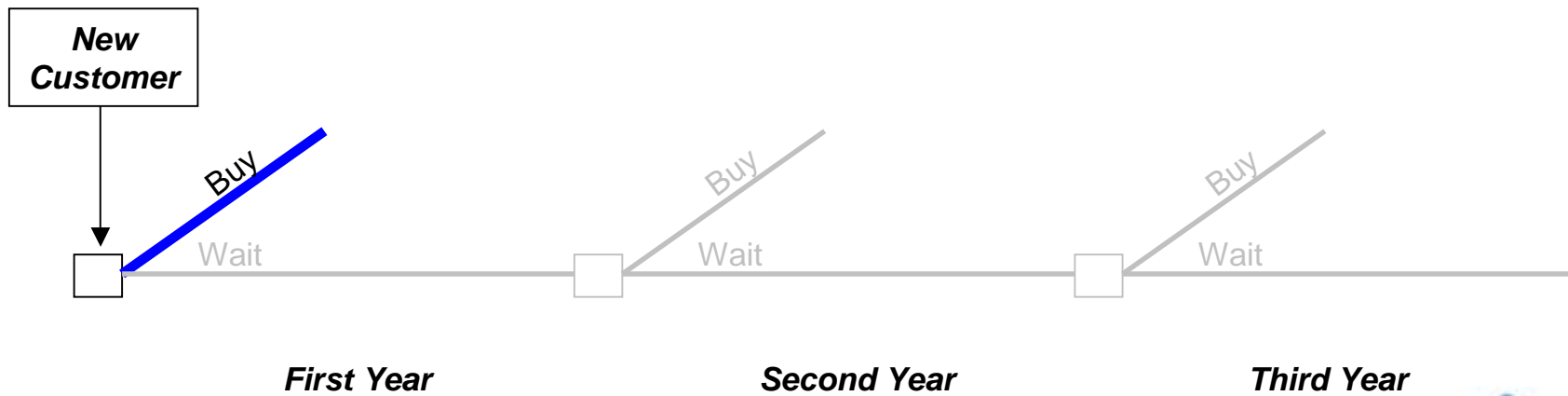
□ = decision    ○ = uncertainty

# Design PBI Structure So Customer Receives No Economic Benefit By Waiting To Purchase



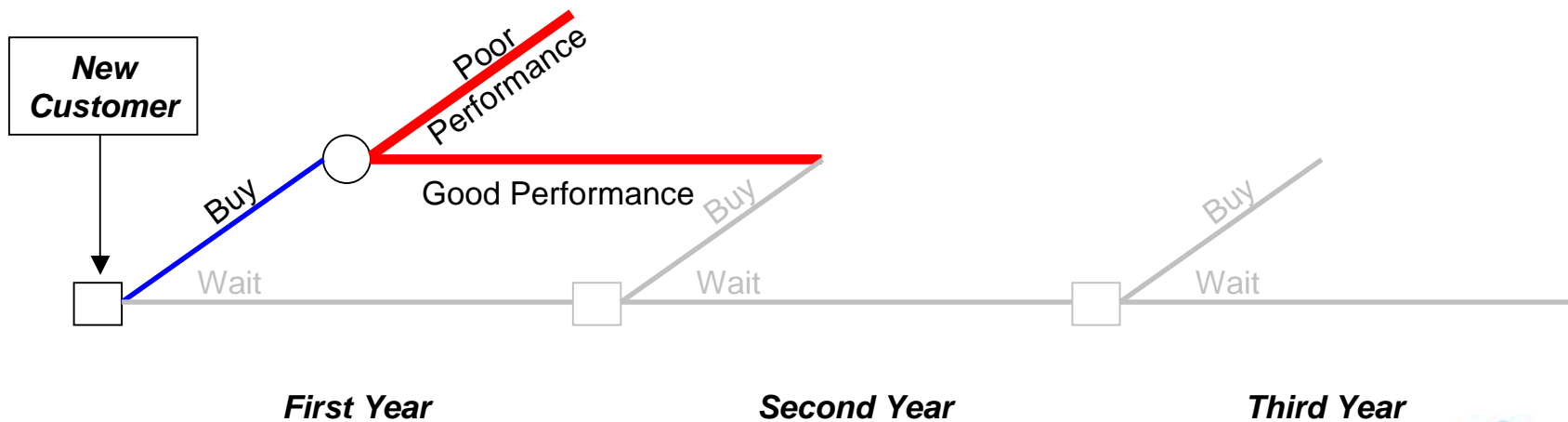
□ = decision    ○ = uncertainty

# If Customer Buys In First Year



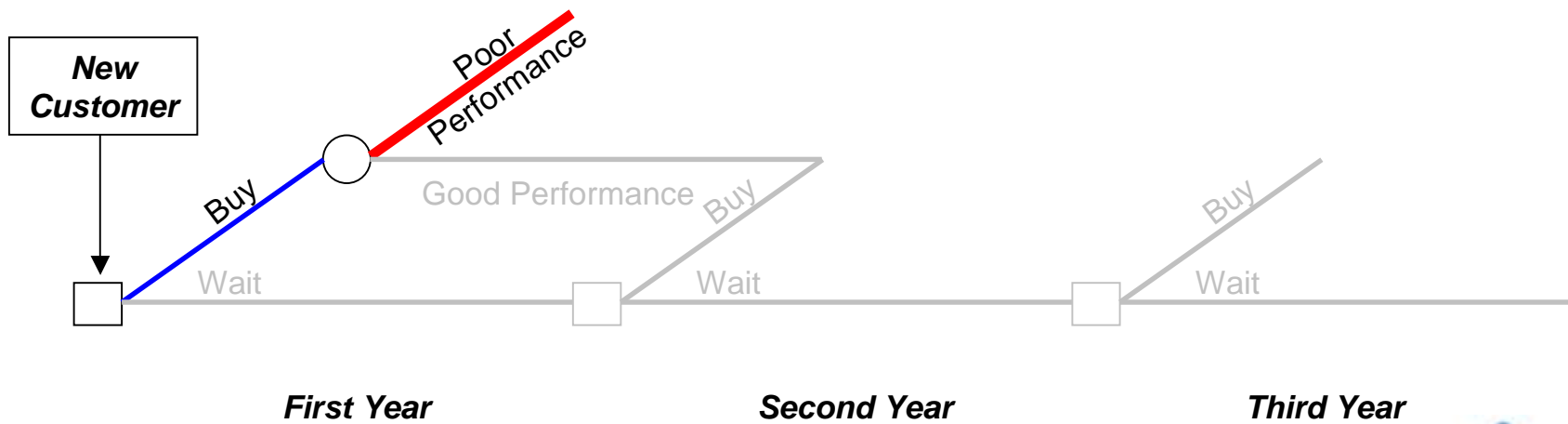
□ = decision    ○ = uncertainty

# Utility Faces Uncertainty About Performance



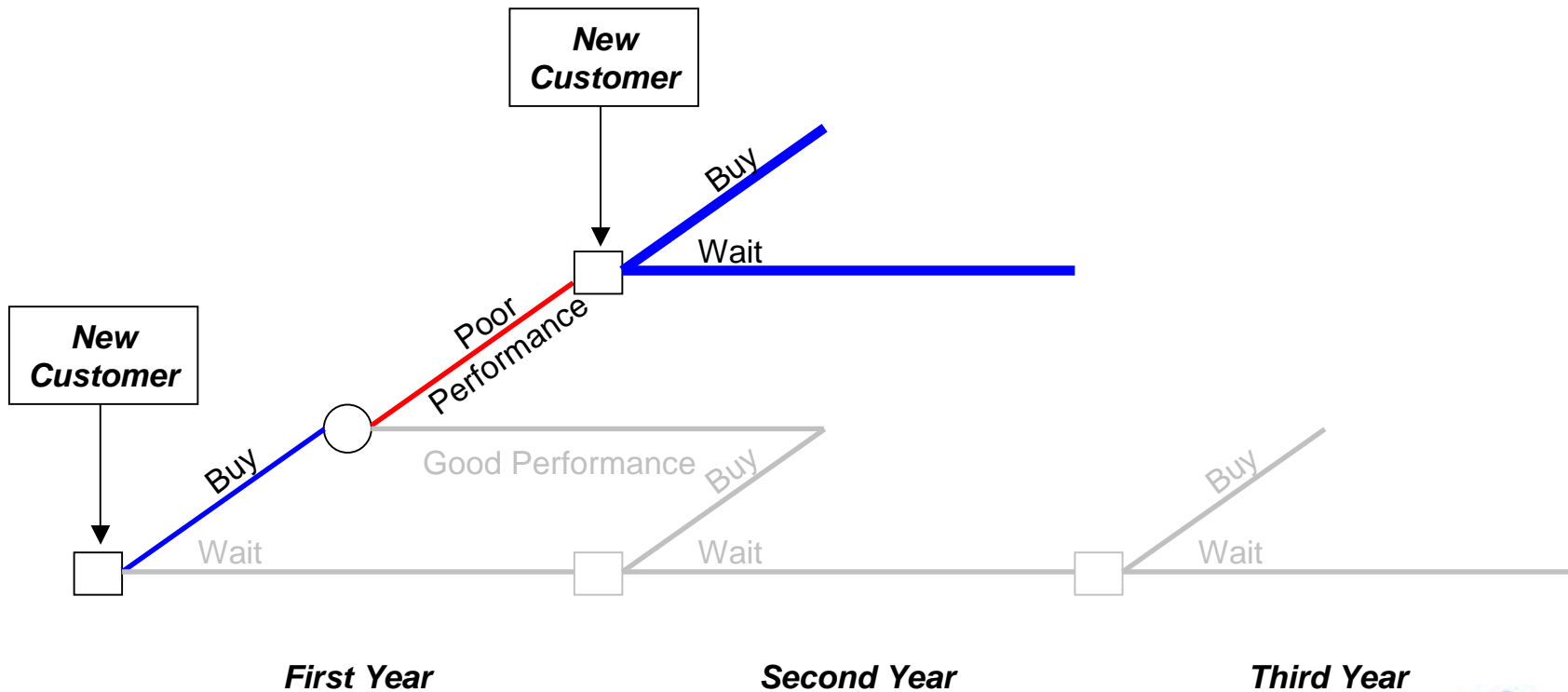
□ = decision    ○ = uncertainty

# If System Fails In First Year ...



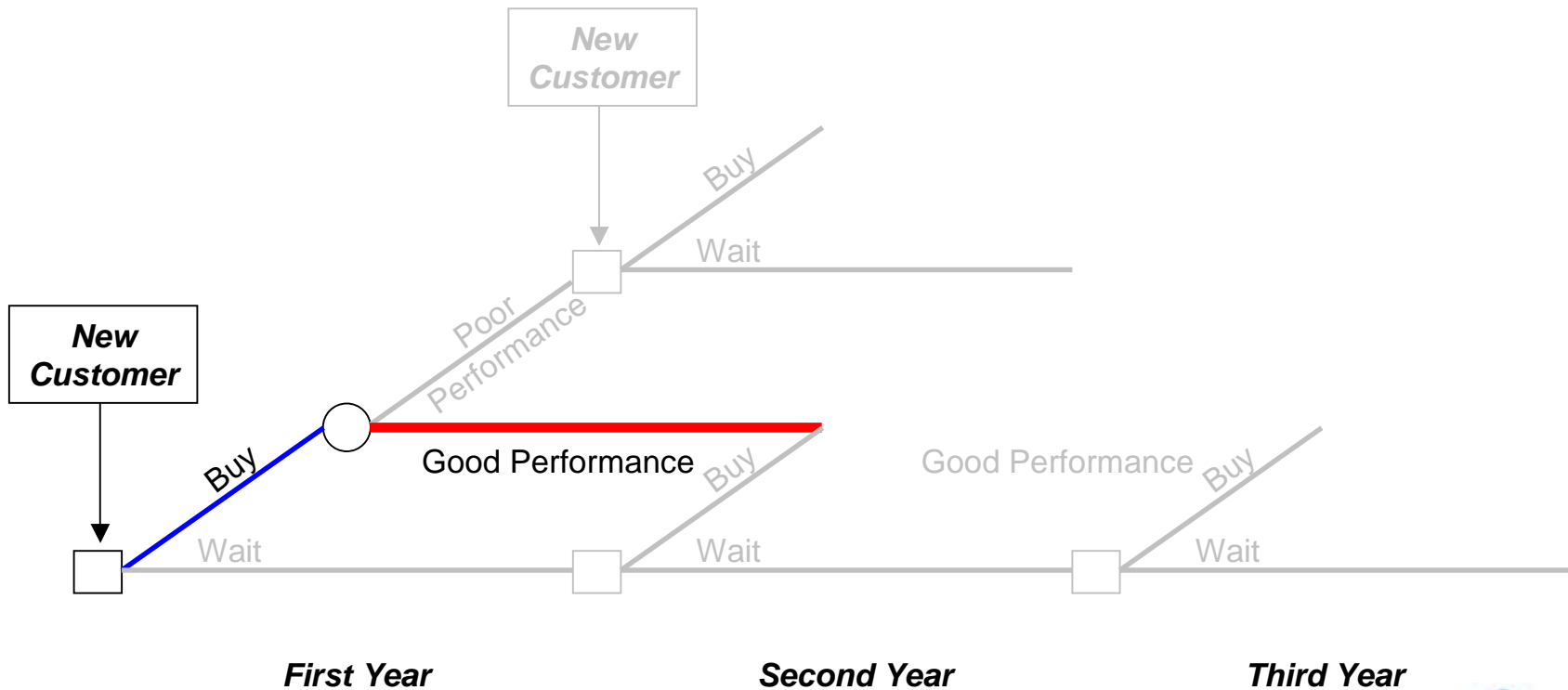
□ = decision    ○ = uncertainty

# PBI Structure Should Protect Utility

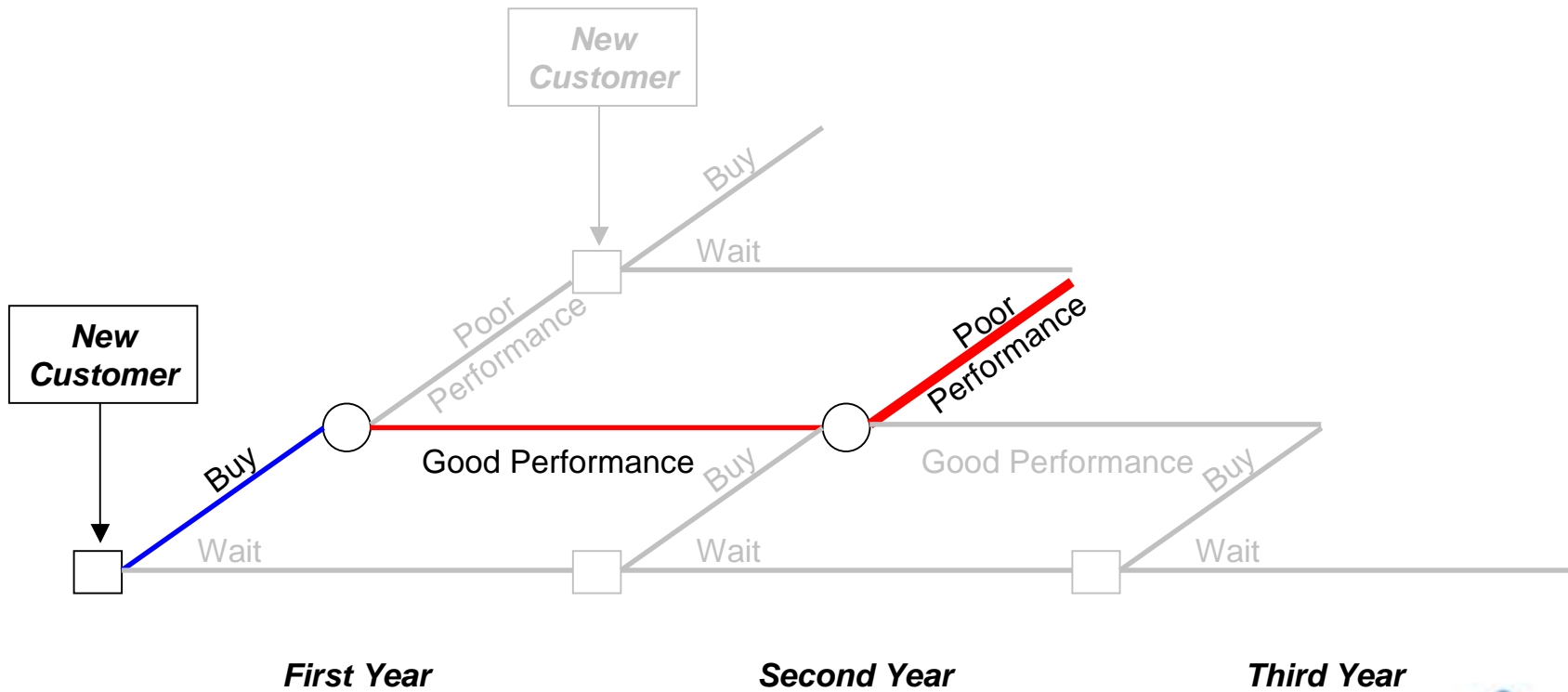


□ = decision    ○ = uncertainty

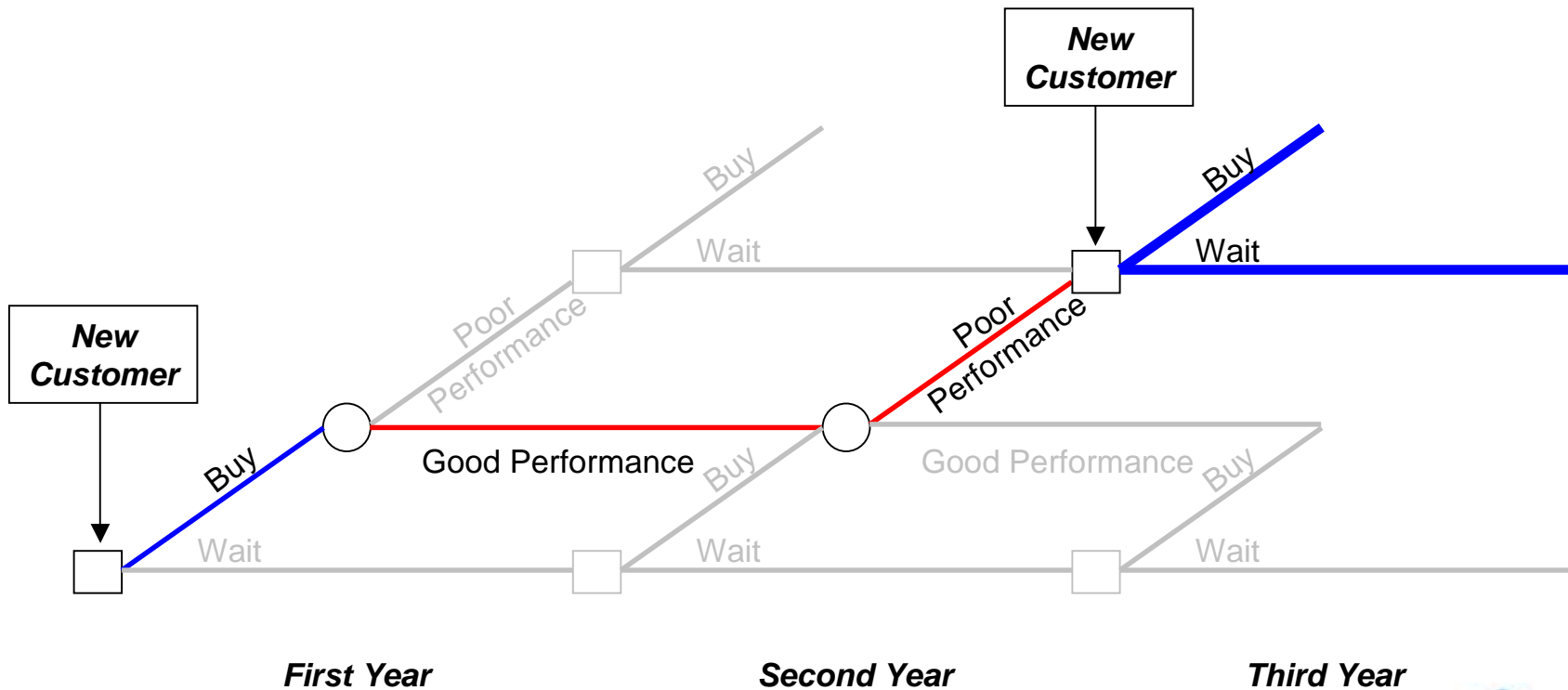
# If System Has Good Performance First Year



# But Fails in Second Year

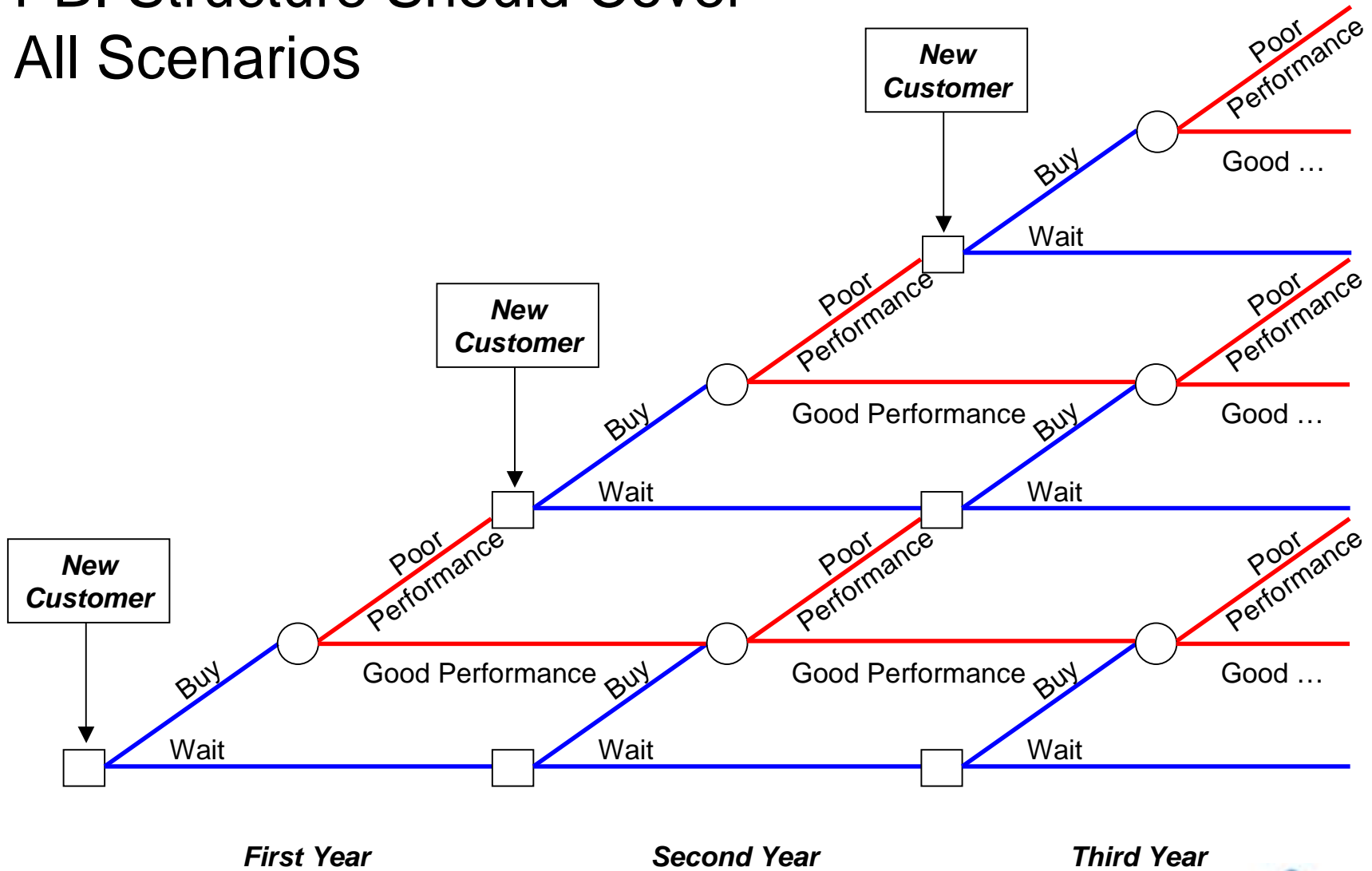


# PBI Structure Should Protect Utility



□ = decision    ○ = uncertainty

# PBI Structure Should Cover All Scenarios

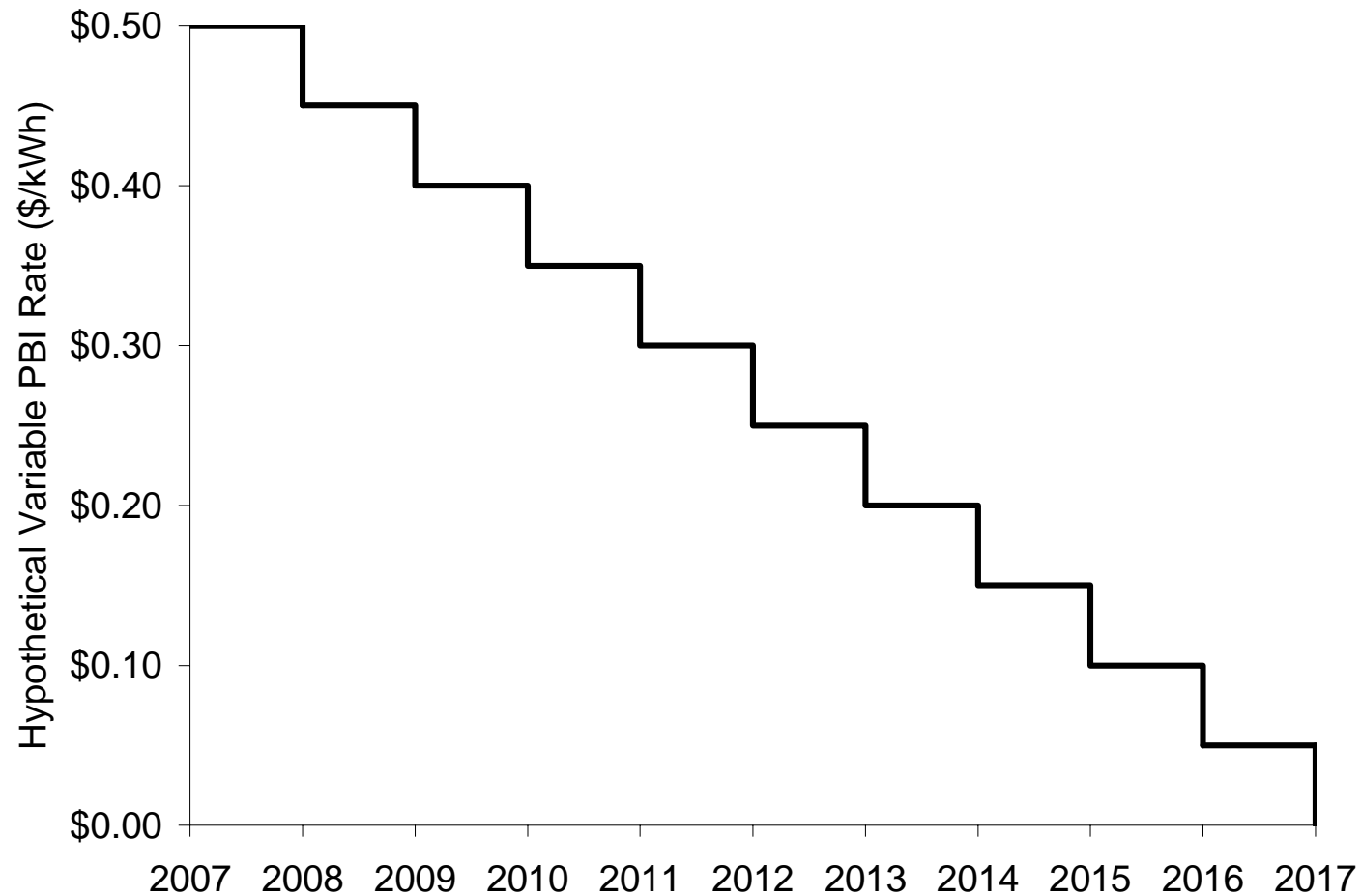


□ = decision    ○ = uncertainty

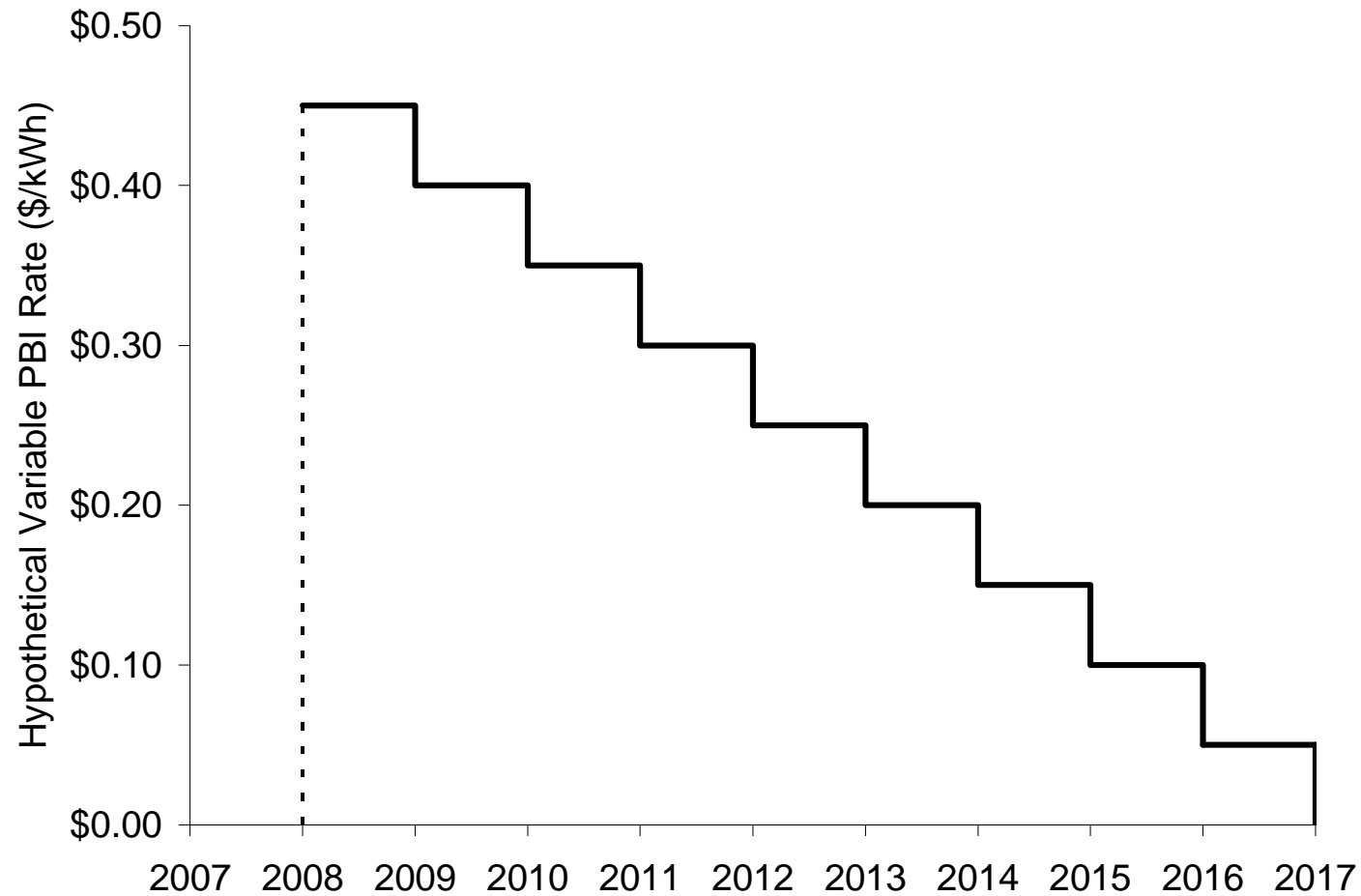
## PBI Structure Must Satisfy Customer & Utility

- Customer's Perspective: Investment is “cost-effective” and customer receives no economic benefit by waiting to purchase
- Utility's Perspective: PBI structure protect utility from poor system performance
- ***PBI Structure that satisfies both is fixed from year to year with declining rate, decreasing duration***

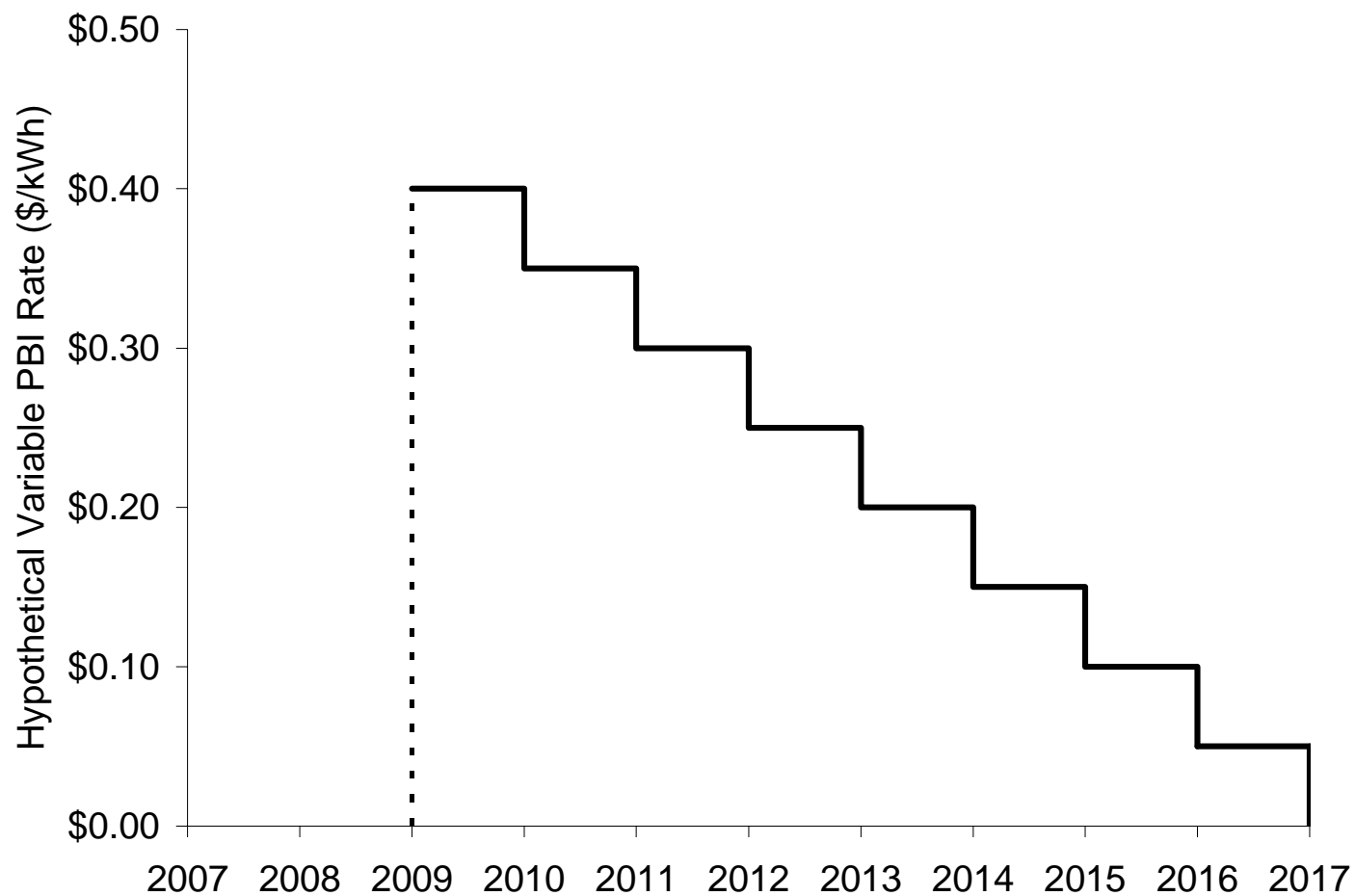
# Proposed PBI: Fixed From Year to Year With Declining Rate, Decreasing Duration



# Wait 1 Year, Forfeit 1 Year of PBI

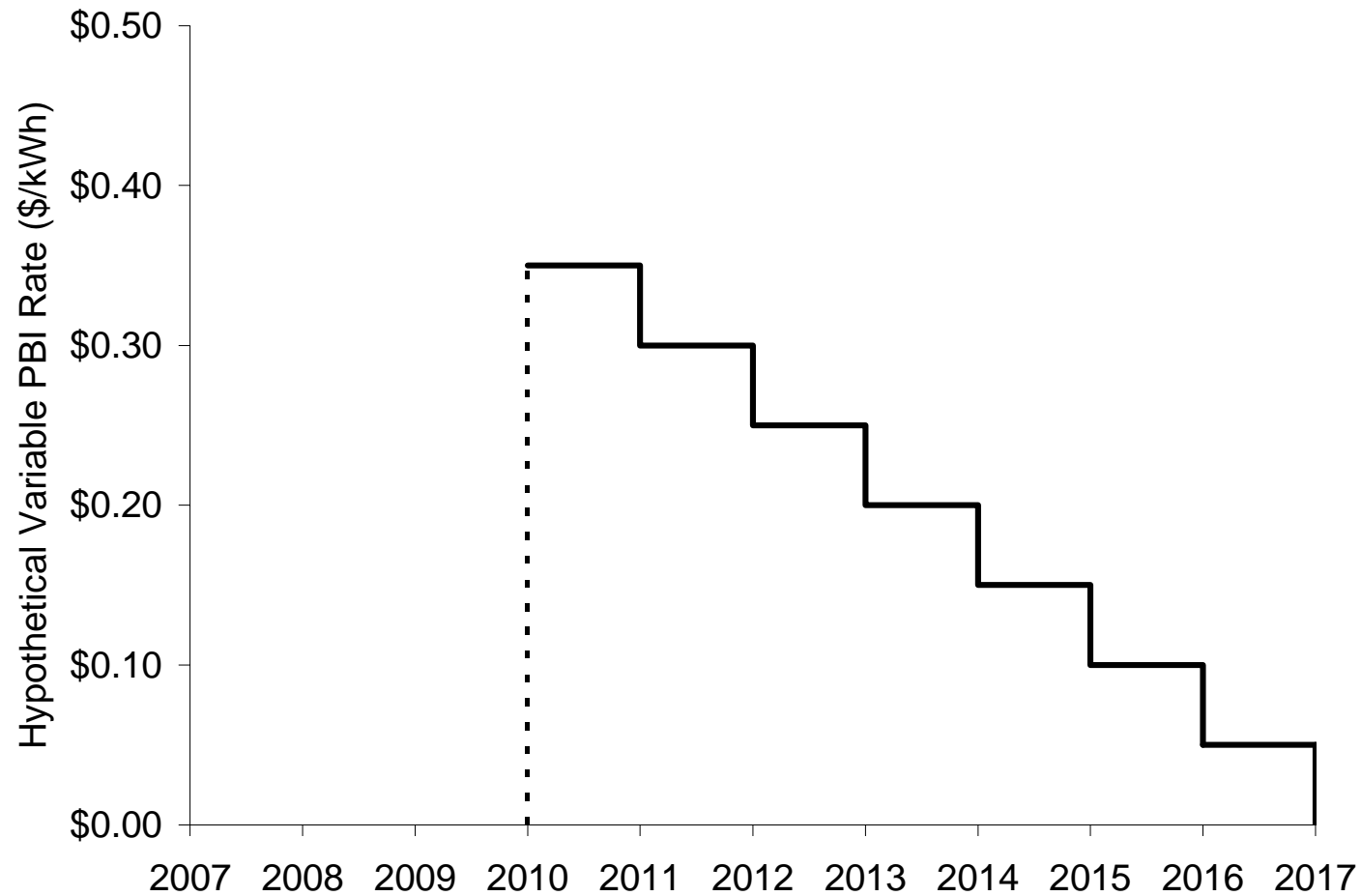


# Wait 2 Years, Forfeit 2 Years of PBI



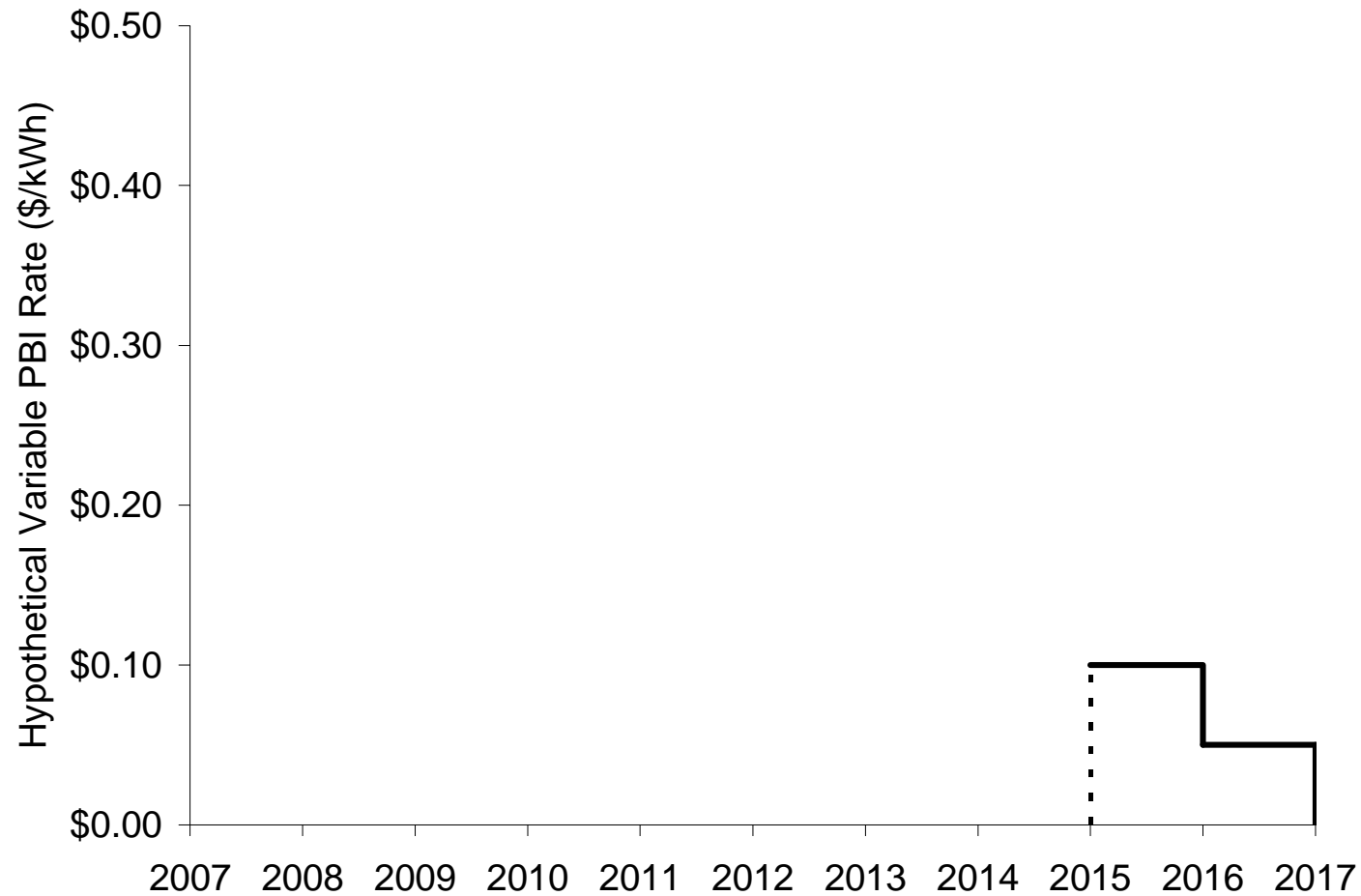


# Wait 3 Years, Forfeit 3 Years of PBI

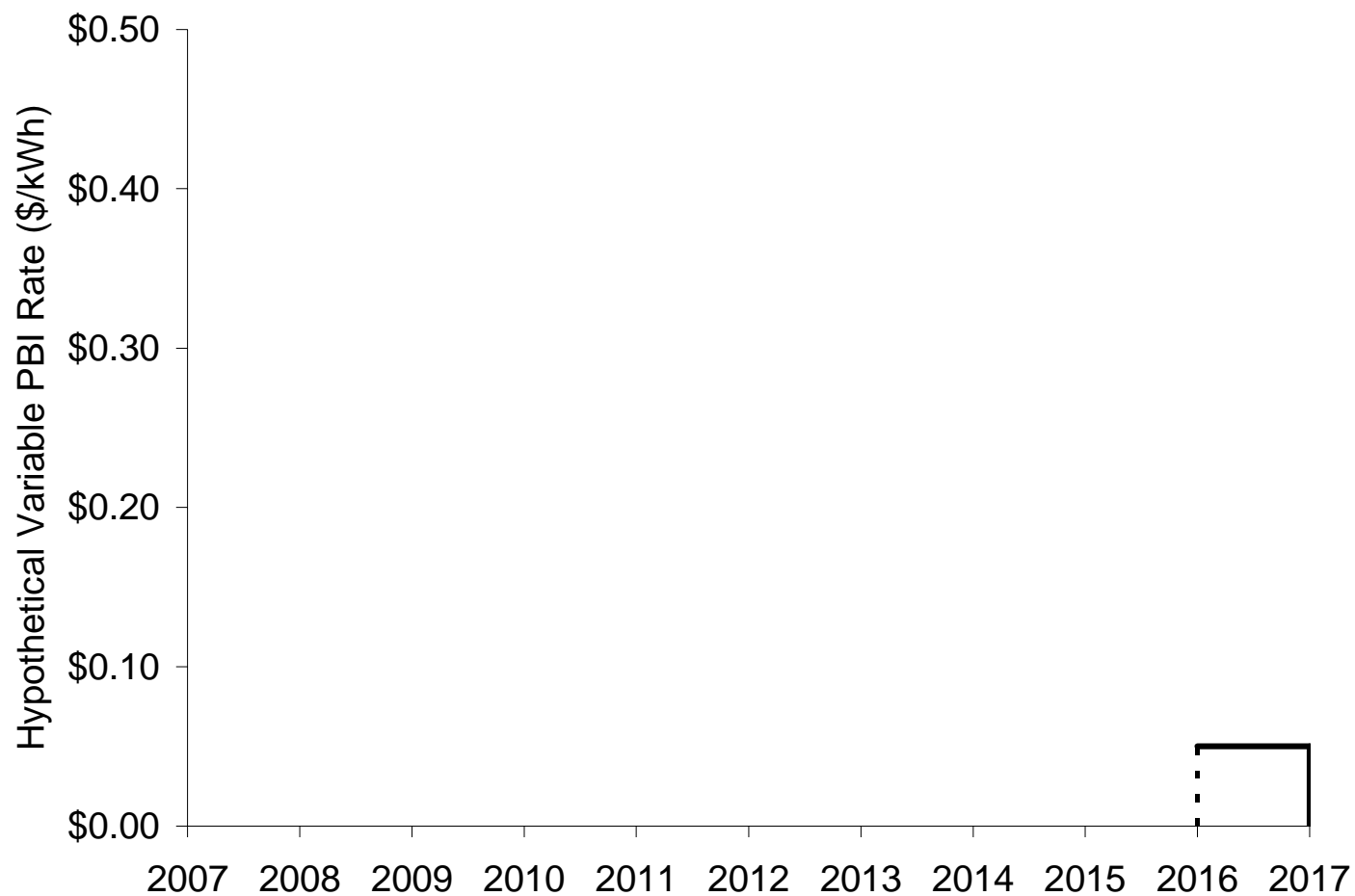




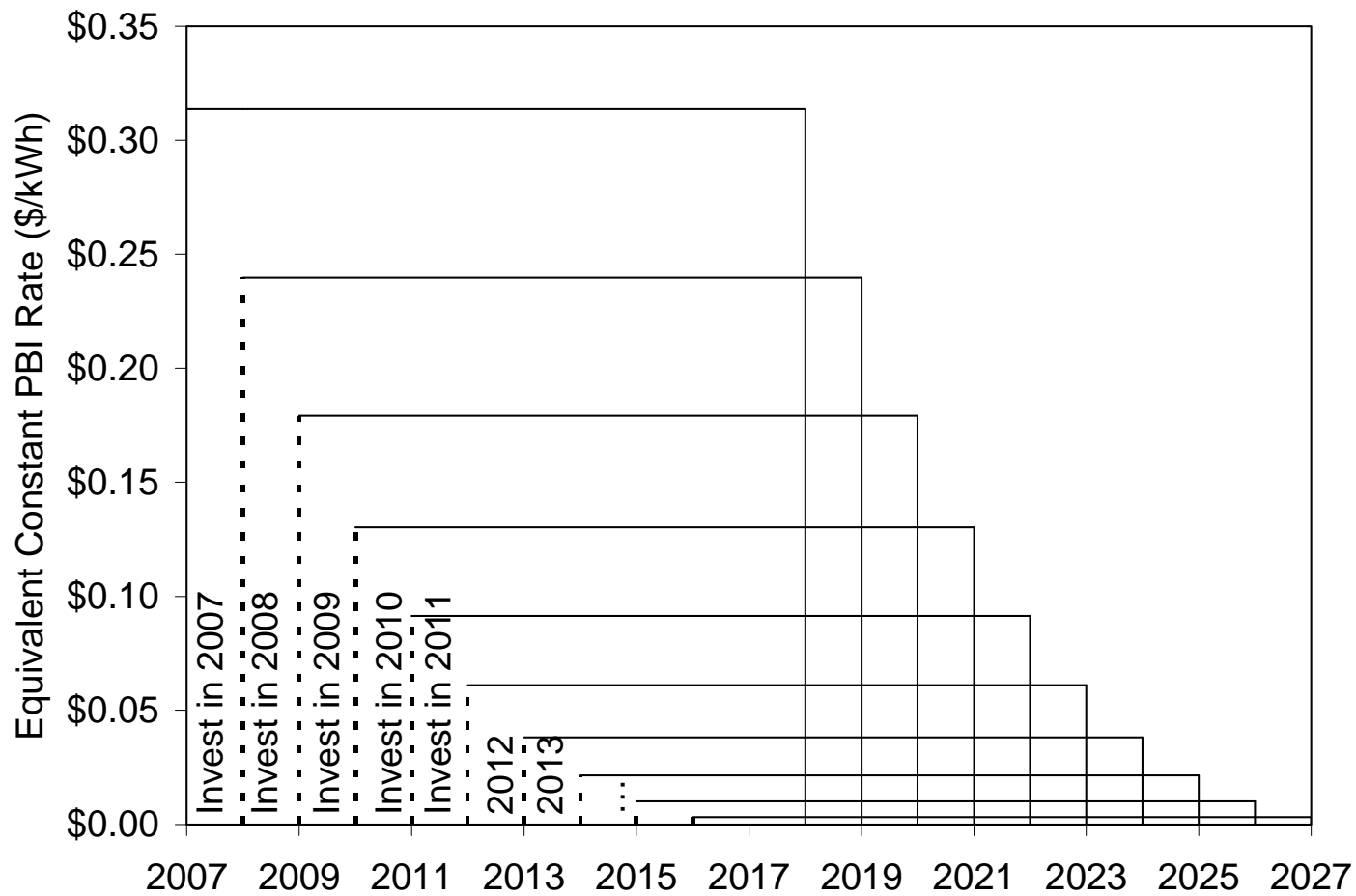
# Wait 8 Years, Forfeit 8 Years of PBI



# Wait 9 Years, Forfeit 9 Years of PBI



# How Does This Compare to Typical PBI?



## PBI Structure Advantages

- Is simple for customer to evaluate
- Can eliminate the expected benefit of waiting
- Eliminates customer value discontinuities
- Protects against a barrage of “last minute” filings
- Provides natural transition to competitive market
- Reduces cost due to time value of money
- Reduces admin costs due to shorter duration
- Can be calibrated to market conditions

## Sample PBI Design: What is 2007 PBI?

- 100 kW system is to be installed
- System produces 165,000 kWh per year
- System costs \$600,000 in 2007
- System will cost \$550,000 in 2008
- System reduces the annual utility bill by \$20,000
- Savings escalate at 3 percent per year
- Tax effects are excluded
- Discount rate is 10 percent

# Compare Buy Now Vs. Wait 1 Year

	2007	2008	2009	...	2036	2037
<b><i>Buy Now</i></b>						
Bill Savings	\$20K	\$20.6K	\$21.2K	...	\$47.1K	
Incentive	I <sub>2007</sub>	I <sub>2008</sub>	I <sub>2009</sub>	...		
System Cost	-\$600K					
<b><i>Wait 1 Year</i></b>						
Bill Savings		\$20.6K	\$21.2K	...	\$47.1K	\$48.5K
Incentive		I <sub>2008</sub>	I <sub>2009</sub>	...		
System Cost		-\$550K				

# Set Alternatives Equal to Each Other

	2007	2008	2009	...	2036	2037
<b><i>Buy Now</i></b>						
Bill Savings	\$20K	\$20.6K	\$21.2K	...	\$47.1K	
Incentive	I <sub>2007</sub>	I <sub>2008</sub>	I <sub>2009</sub>	...		
System Cost	-\$600K					
<b><i>Wait 1 Year</i></b>						
Bill Savings		\$20.6K	\$21.2K	...	\$47.1K	\$48.5K
Incentive		I <sub>2008</sub>	I <sub>2009</sub>	...		
System Cost		-\$550K				
<b><i>Difference: Buy Now Minus Wait 1 Year</i></b>						
Net	I <sub>2007</sub> - \$580K	\$550K	0	...	0	-\$48.5K
Net (Discounted)	I <sub>2007</sub> - \$580K	\$500K	0	...	0	-\$2.8K

## PBI Must Be \$82.8K in 2007

$$(\text{PBI in 2007}) - \$580\text{k} + \$500\text{k} - \$2.8\text{k} = \$0$$

# General Customer Value Problem Formulation

$$\begin{aligned} & \text{Discounted Sum of Utility Bill Savings} \\ & + \text{Discounted Sum of PBI} \\ & - \text{Price} \\ \hline & = \text{Net Value} \end{aligned}$$

# Establish PBI Rate So Net Value is Constant

***For each year where cost-effectiveness test not reached:***

Cost Premium of Investing Now

- Benefit of Higher Utility Bill Savings

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= Performance Based Incentive

## Numerical Result (Previous Example)

$$\text{Cost Premium} = (\$600,000 - \$550,000 / 1.1) / 165,000 = \$0.60/\text{kWh}$$

$$\text{- Benefit} = (\$20,000 - \$48,500 / 1.1^{30}) / 165,000 = \$0.10/\text{kWh}$$

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$$\text{PBI (2007)} = \$0.50/\text{kWh}$$

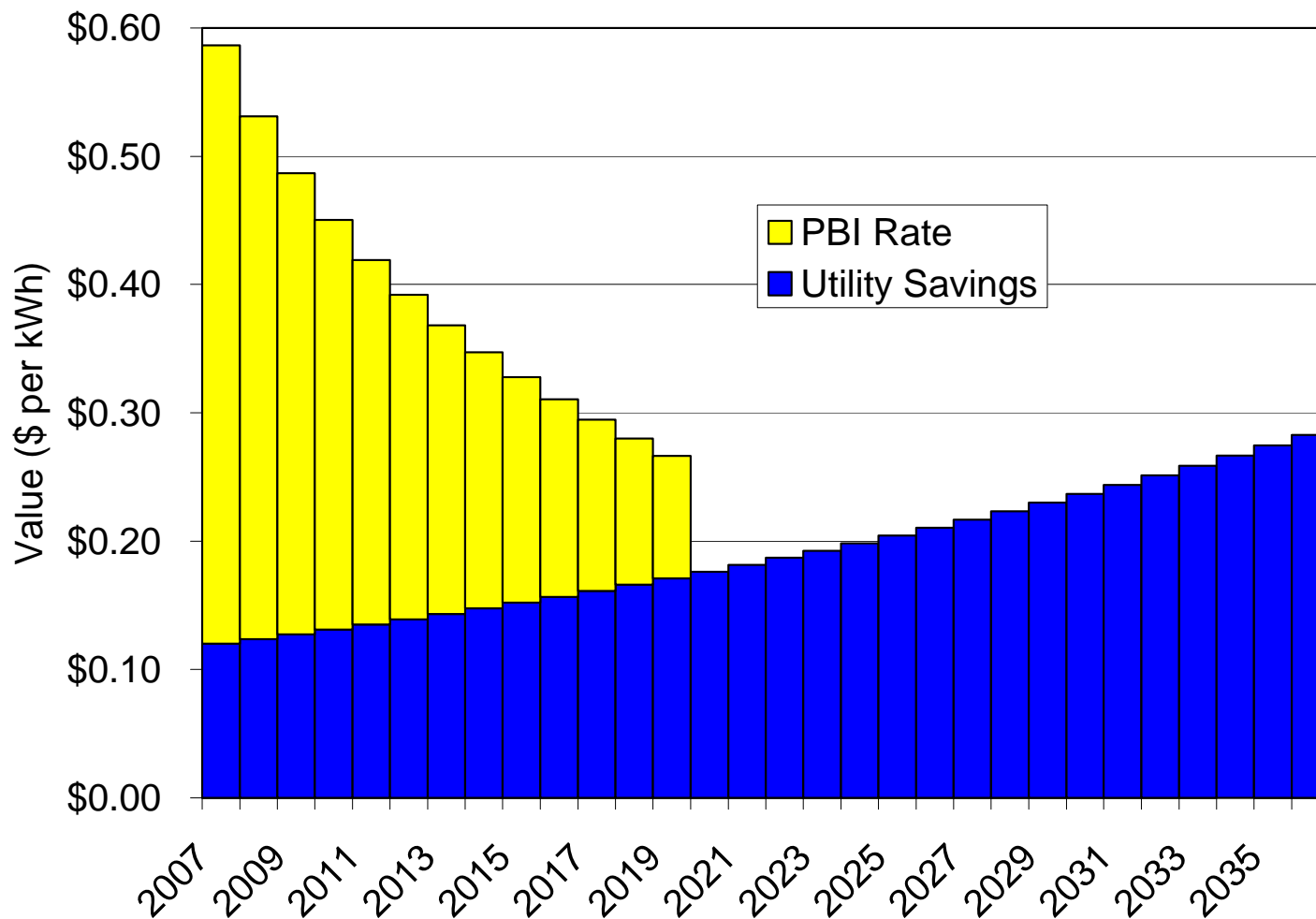
# Detailed Example

Utility Savings	
<i>Average Utility Savings (<math>U_0</math>)</i>	\$0.12 per kWh
<i>Savings Escalation (e)</i>	3% per year
<i>PV Is Cost Effective When</i>	10 yrs savings > cost
PV System	
<i>Effective Price (<math>P_0</math>)</i>	\$6,000 per kW
<i>Energy Production (E)</i>	1,650 per kW per year
<i>System Life (L)</i>	30 years
PV Market Estimate	
<i>Installed PV Capacity (<math>Q_0</math>)</i>	5.00 GW
<i>Annual PV Sales</i>	1.50 GW per year
<i>Growth in Sales</i>	20% per year
<i>Progress Ratio (PR)</i>	82%
General	
<i>Discount Rate (r)</i>	10%

# Results

	<i>Cumulative PV Capacity (GW)</i>	<i>Annual PV Sales (GW)</i>	<i>Effective PV System Price</i>	<i>Utility Savings</i>	<i>PBI Rate</i>
<b>2007</b>	5.0	1.5	\$6,000	\$0.12	<b>\$0.47</b>
<b>2008</b>	6.5	1.8	\$5,566	\$0.12	<b>\$0.41</b>
<b>2009</b>	8.3	2.2	\$5,190	\$0.13	<b>\$0.36</b>
<b>2010</b>	10.5	2.6	\$4,857	\$0.13	<b>\$0.32</b>
<b>2011</b>	13.1	3.1	\$4,559	\$0.14	<b>\$0.28</b>
<b>2012</b>	16.2	3.7	\$4,288	\$0.14	<b>\$0.25</b>
<b>2013</b>	19.9	4.5	\$4,040	\$0.14	<b>\$0.22</b>
<b>2014</b>	24.4	5.4	\$3,812	\$0.15	<b>\$0.20</b>
<b>2015</b>	29.7	6.4	\$3,601	\$0.15	<b>\$0.18</b>
<b>2016</b>	36.2	7.7	\$3,404	\$0.16	<b>\$0.15</b>
<b>2017</b>	43.9	9.3	\$3,220	\$0.16	<b>\$0.13</b>
<b>2018</b>	53.2	11.1	\$3,048	\$0.17	<b>\$0.11</b>
<b>2019</b>	64.4	13.4	\$2,887	\$0.17	<b>\$0.10</b>
<b>2020</b>	77.7	16.0	\$2,735	\$0.18	<b>\$0.00</b>
<b>2021</b>	93.8	19.3	\$2,592	\$0.18	<b>\$0.00</b>
<b>2022</b>	113.1	23.1	\$2,457	\$0.19	<b>\$0.00</b>
<b>2023</b>	136.2	27.7	\$2,330	\$0.19	<b>\$0.00</b>
<b>2024</b>	163.9	33.3	\$2,209	\$0.20	<b>\$0.00</b>
<b>2025</b>	197.2	39.9	\$2,095	\$0.20	<b>\$0.00</b>
<b>2026</b>	237.1	47.9	\$1,988	\$0.21	<b>\$0.00</b>

# Results



# Validation

	<i>Annual Benefit</i>	<i>30-yr NPV Savings</i>	<i>Effective PV System Price</i>	<i>Savings - Cost</i>	<i>Discounted Savings - Cost</i>
<b>2007</b>	\$968	\$6,347	\$6,000	\$347	<b>\$347</b>
<b>2008</b>	\$876	\$5,948	\$5,566	\$382	<b>\$347</b>
<b>2009</b>	\$803	\$5,610	\$5,190	\$420	<b>\$347</b>
<b>2010</b>	\$743	\$5,319	\$4,857	\$462	<b>\$347</b>
<b>2011</b>	\$691	\$5,067	\$4,559	\$508	<b>\$347</b>
<b>2012</b>	\$647	\$4,847	\$4,288	\$559	<b>\$347</b>
<b>2013</b>	\$608	\$4,656	\$4,040	\$615	<b>\$347</b>
<b>2014</b>	\$573	\$4,489	\$3,812	\$677	<b>\$347</b>
<b>2015</b>	\$541	\$4,345	\$3,601	\$744	<b>\$347</b>
<b>2016</b>	\$512	\$4,223	\$3,404	\$819	<b>\$347</b>
<b>2017</b>	\$486	\$4,121	\$3,220	\$901	<b>\$347</b>
<b>2018</b>	\$462	\$4,039	\$3,048	\$991	<b>\$347</b>
<b>2019</b>	\$440	\$3,977	\$2,887	\$1,090	<b>\$347</b>
<b>2020</b>	\$291	\$3,934	\$2,735	\$1,199	<b>\$347</b>
<b>2021</b>	\$299	\$4,052	\$2,592	\$1,460	<b>\$384</b>
<b>2022</b>	\$308	\$4,173	\$2,457	\$1,716	<b>\$411</b>
<b>2023</b>	\$318	\$4,298	\$2,330	\$1,969	<b>\$428</b>
<b>2024</b>	\$327	\$4,427	\$2,209	\$2,218	<b>\$439</b>
<b>2025</b>	\$337	\$4,560	\$2,095	\$2,465	<b>\$443</b>
<b>2026</b>	\$347	\$4,697	\$1,988	\$2,709	<b>\$443</b>

## Conclusions

- There is a single PBI payment structure
- There is a set number of years for which the payment should be made
- The incentive structure should reflect a declining PBI payment each year, known in advance to all prospective PV investors
- Customers who wait to invest forfeit PBI payments from the early years

## Next Steps

- Incorporate state and federal tax effects
- Incorporate regional feedback into PV price
- Select and calibrate the cost-effectiveness test
- Assess how to PBI should respond to demand
- Reflect utility value in PBI rates
- Evaluate administrative activities to implement
- Expand to include the other perspectives
- Incorporate administrative costs