



**CALIFORNIA ISO**

California Independent  
System Operator

# **STEP**

# **Economic Study Results**

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*California ISO Grid Planning*

*October 2, 2003*



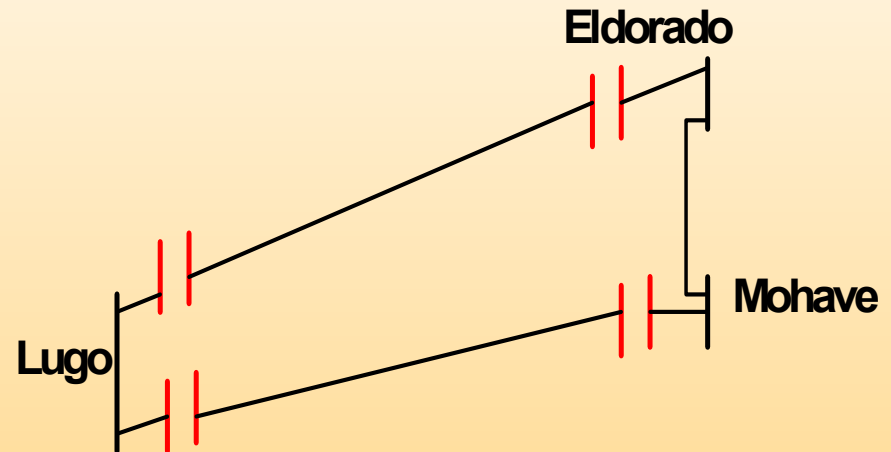
## Overview

- Update on input assumptions.
- Sequence of common upgrades.
- Results.



## Update On Input Assumptions East of Lugo Lines

- Both Eldorado – Lugo and Mohave – Lugo lines have two series capacitor segments each.
- Previous STEP economic studies assumed 70% compensation for each line, which caused Eldorado – Lugo flow to be twice the Mohave – Lugo flow.
- When the compensation level of Eldorado – Lugo is at 35% and Mohave – Lugo is at 70%, both lines have similar flows.

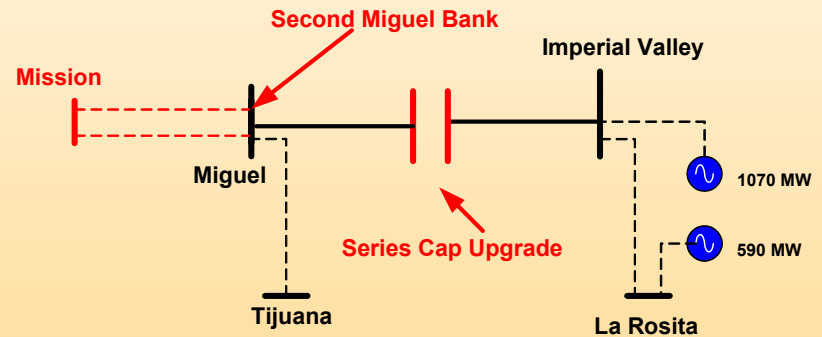




## Update On Input Assumptions

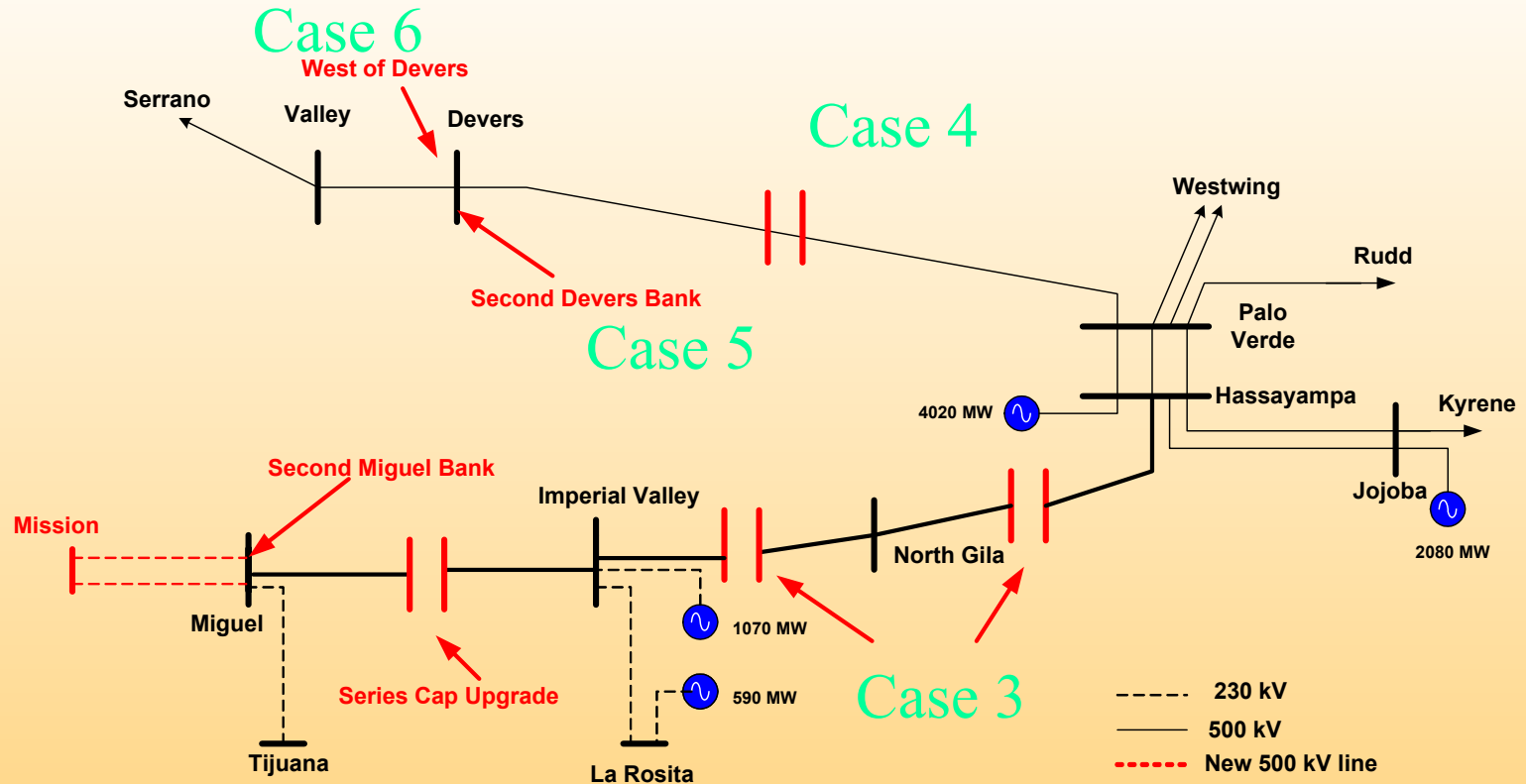
### Miguel Upgrade

- Second Miguel bank, second Miguel – Mission 230 kV Line and Imperial Valley – Miguel series cap upgrade are considered to be in the basecase.





## Sequence of Common Upgrades



- Navajo – Crystal and Moenkopi – Eldorado series capacitor upgrade are added as the final step after considering each specific alternative.



## What is not Modeled

- Bidding behavior
- Contracts and ETCs
- Exact heat rate data
- Wheeling costs
- Unit commitment
- Low-voltage transmission line limits
- Real and reactive losses
- Congestion Revenue



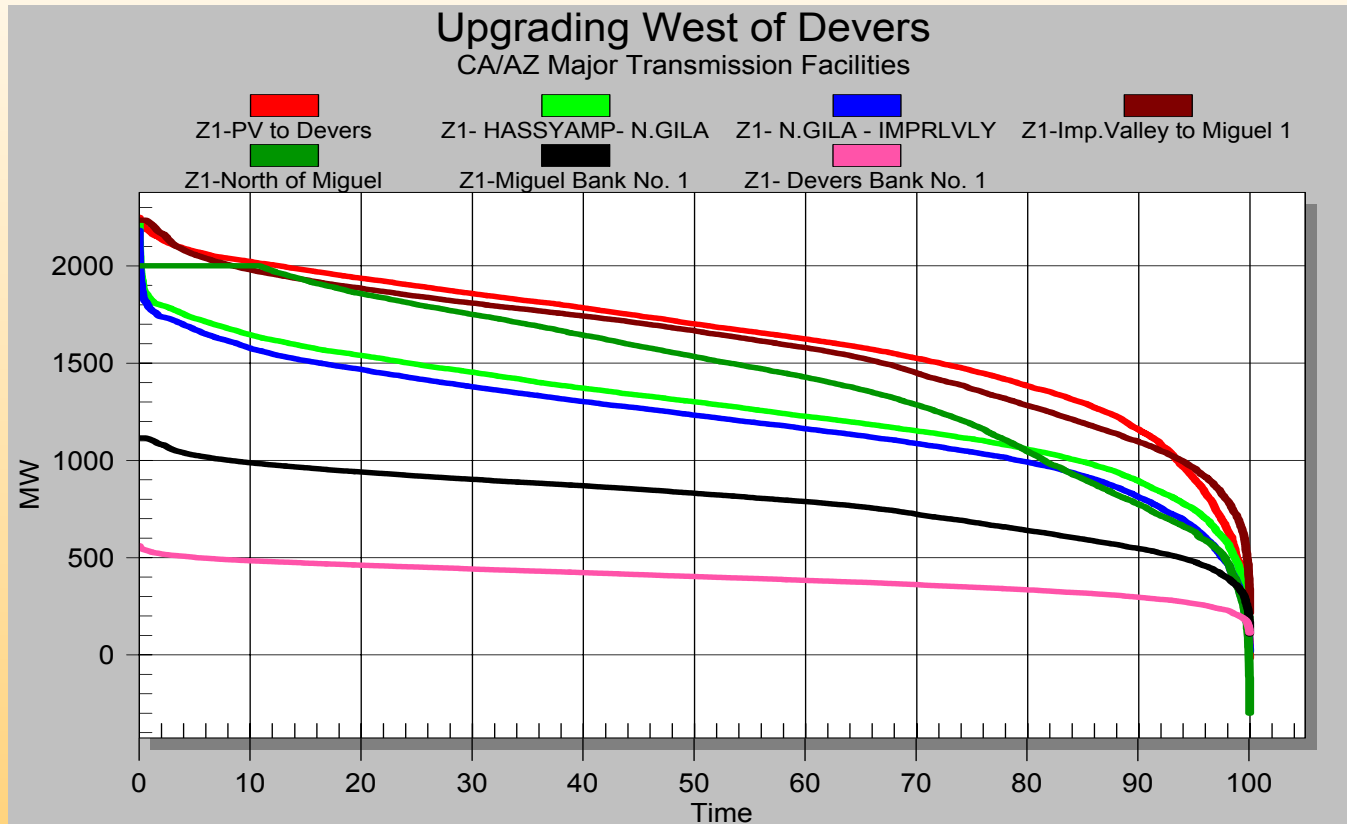
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# Study Results

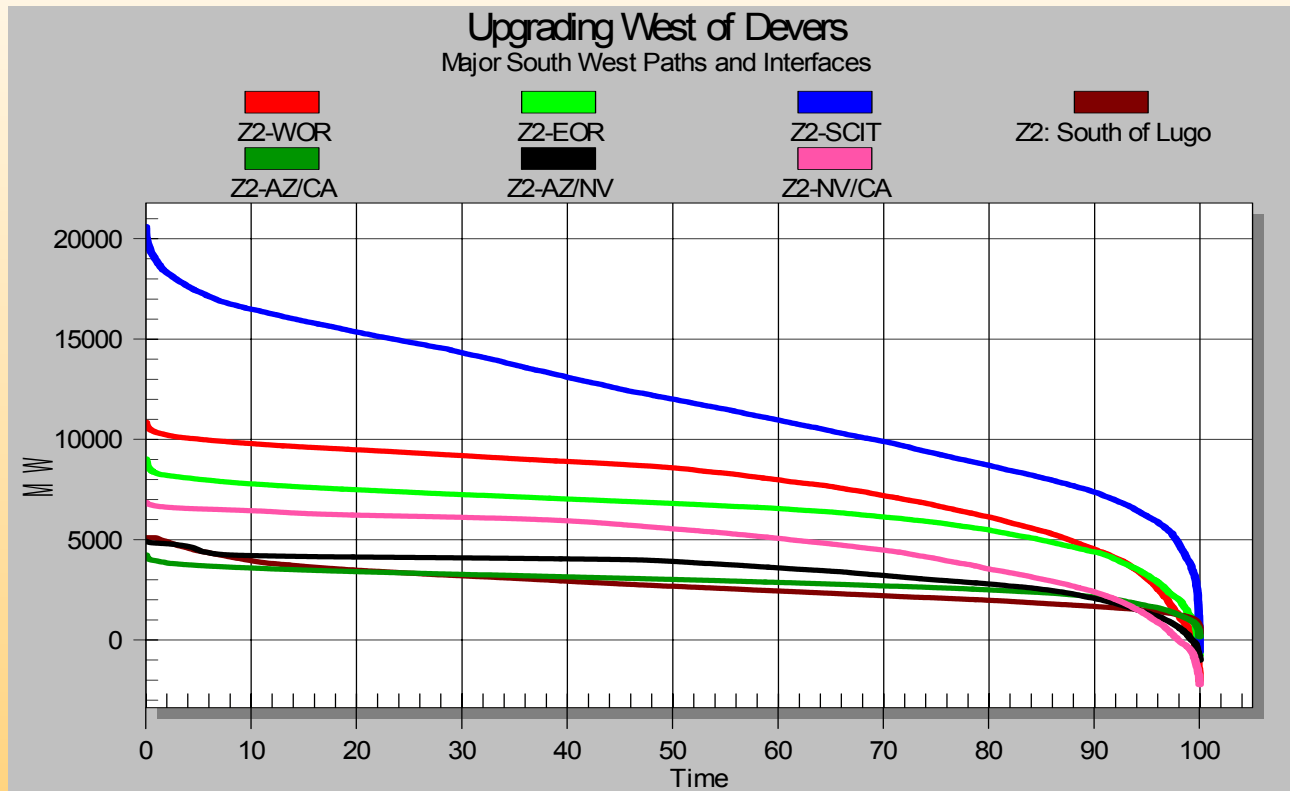


## Common Upgrades



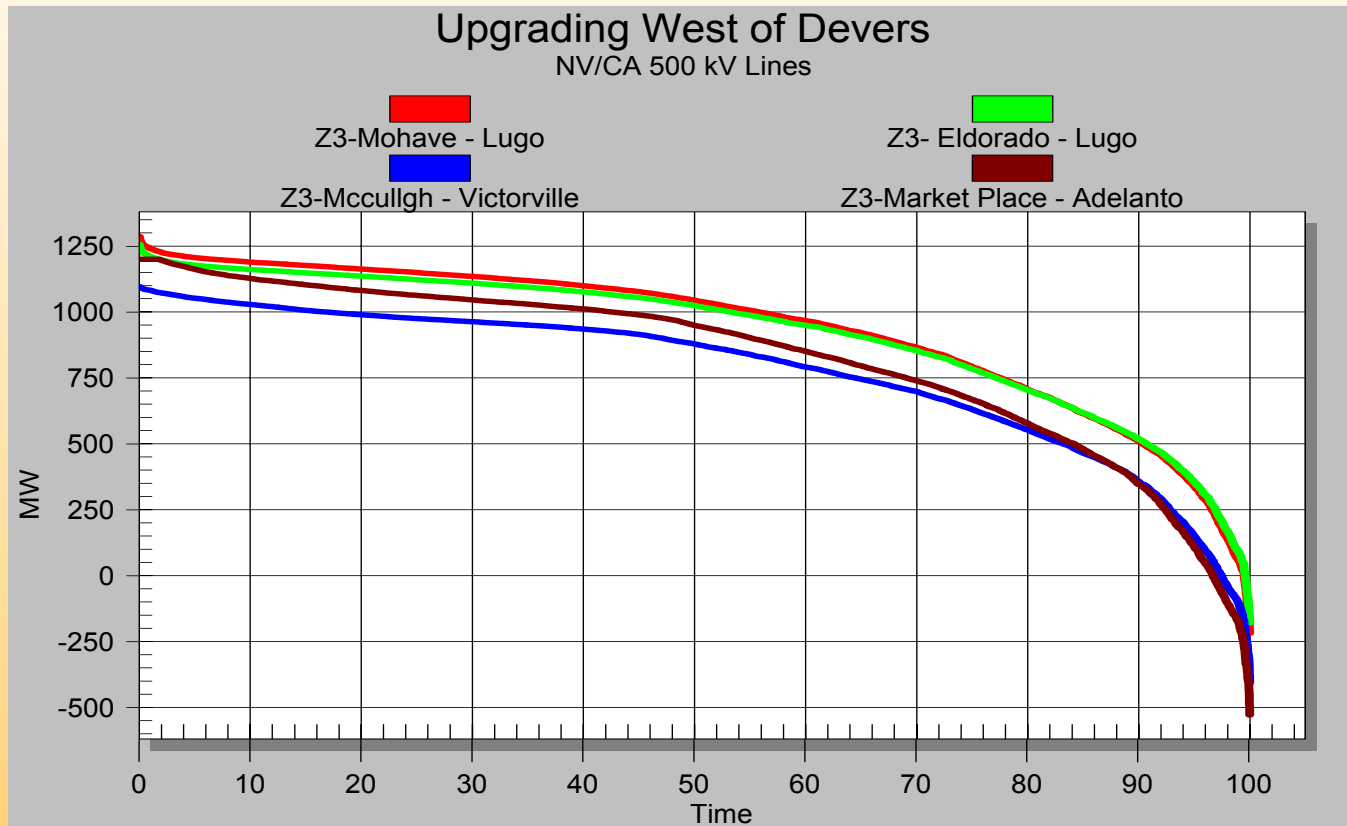


## Common Upgrades



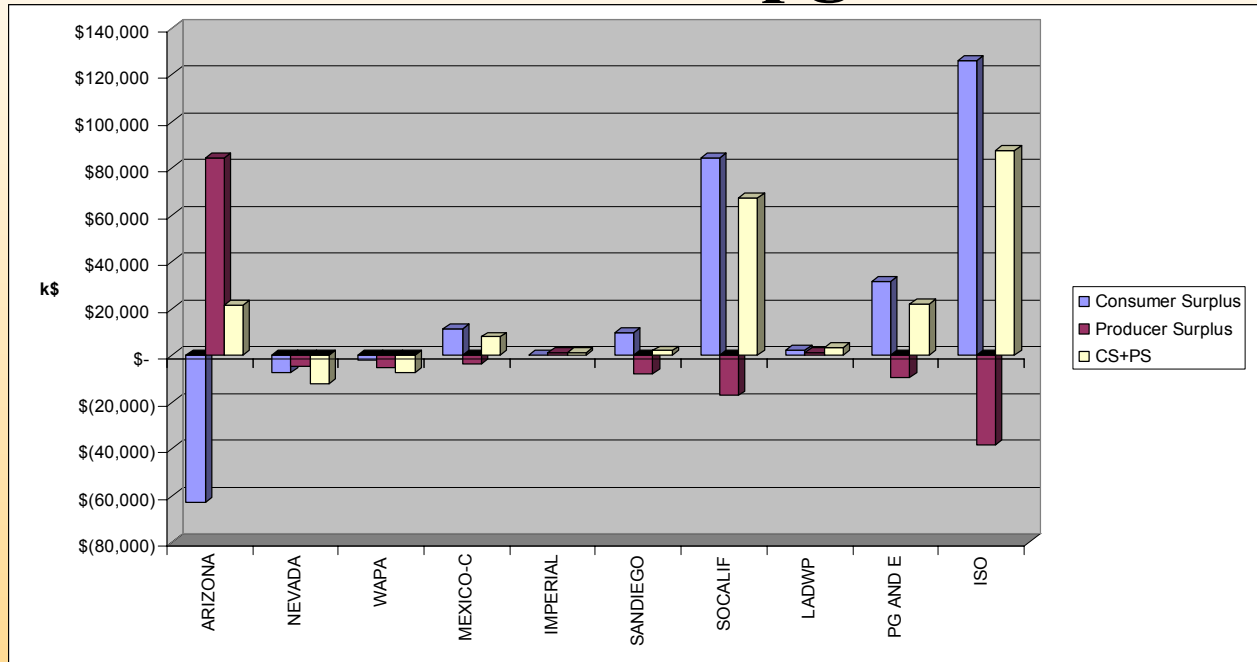


## Common Upgrades





## Accumulative Benefits Due To Common Upgrades

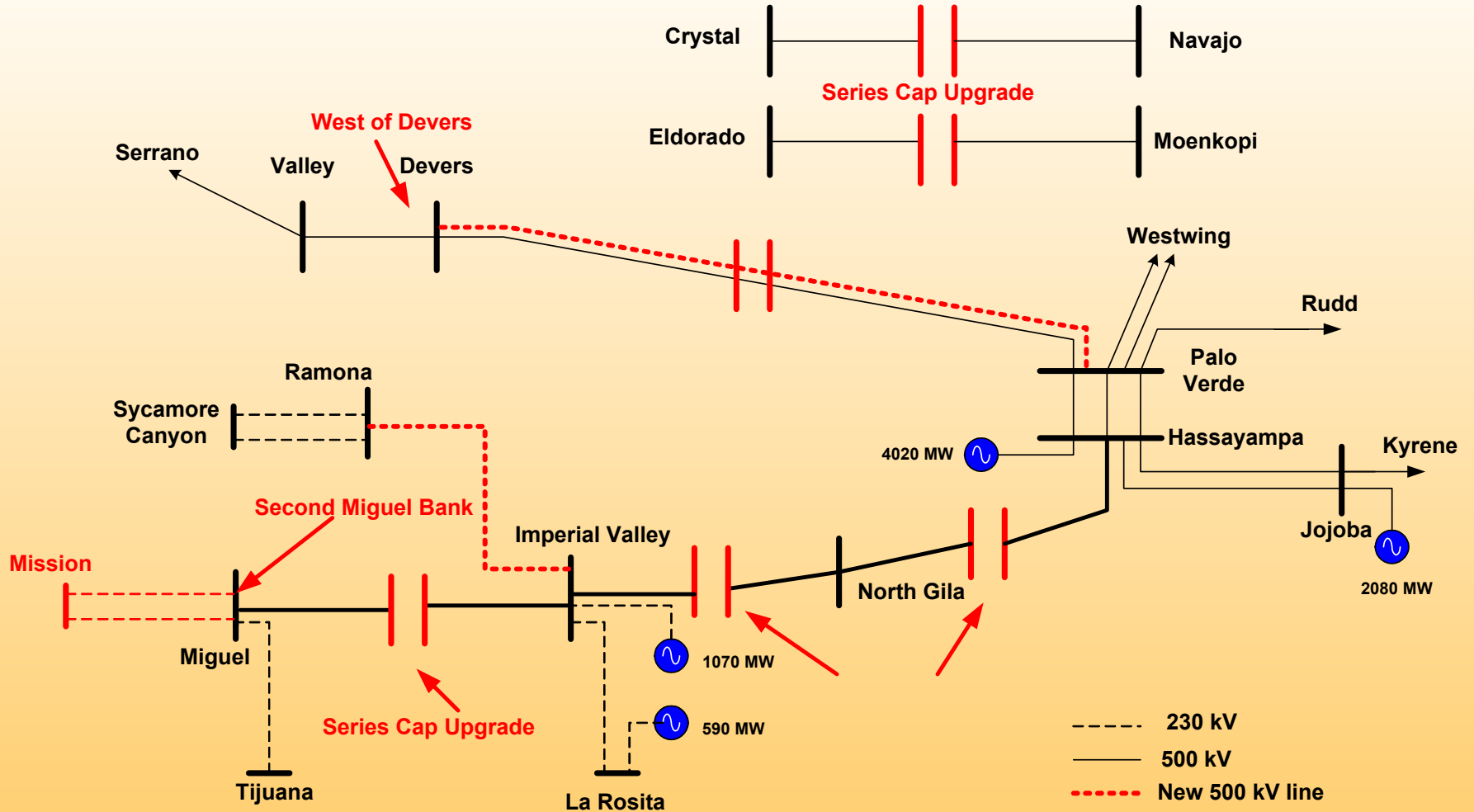


**Levelized Project \$ 44,705.38  
Cost /Year**

	ARIZONA	NEVADA	WAPA	MEXICO-C	IMPERIAL	SANDIEGO	SOCALIF	LADWP	PG AND E	ISO
CS	-\$62,917.00	-\$7,522.00	-\$2,230.00	\$11,299.00	\$173.00	\$9,871.00	\$84,599.00	\$2,185.00	\$31,456.00	\$125,926.00
PS	\$84,395.07	-\$4,824.47	-\$5,103.21	-\$3,449.50	\$1,116.43	-\$7,894.00	-\$17,250.58	\$1,069.11	-\$9,261.70	-\$38,103.85
CS+PS	\$21,478.07	-\$12,346.47	-\$7,333.21	\$7,849.50	\$1,289.43	\$1,977.00	\$67,348.42	\$3,254.11	\$22,194.30	\$87,822.15

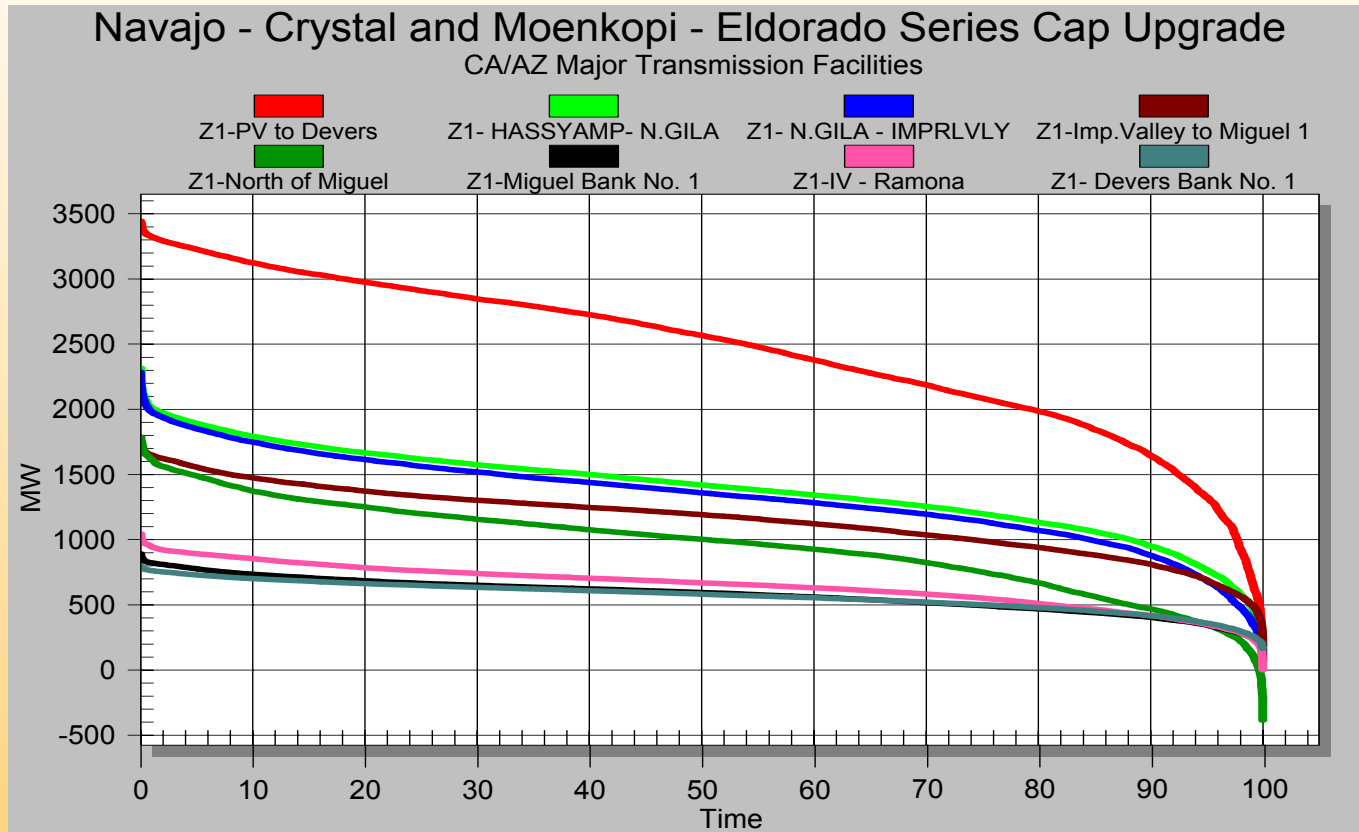


## Common Upgrades and AC 1



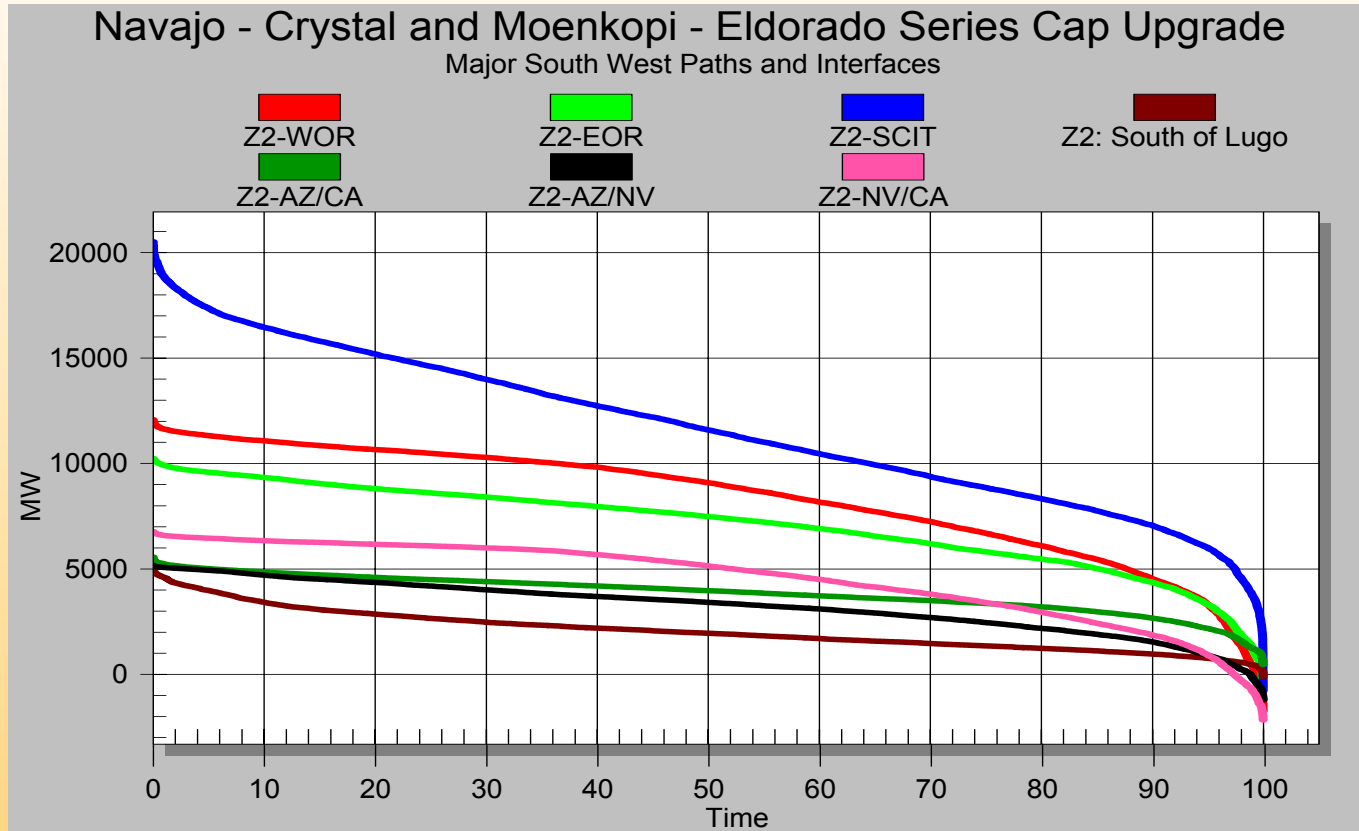


## Common Upgrades and AC 1



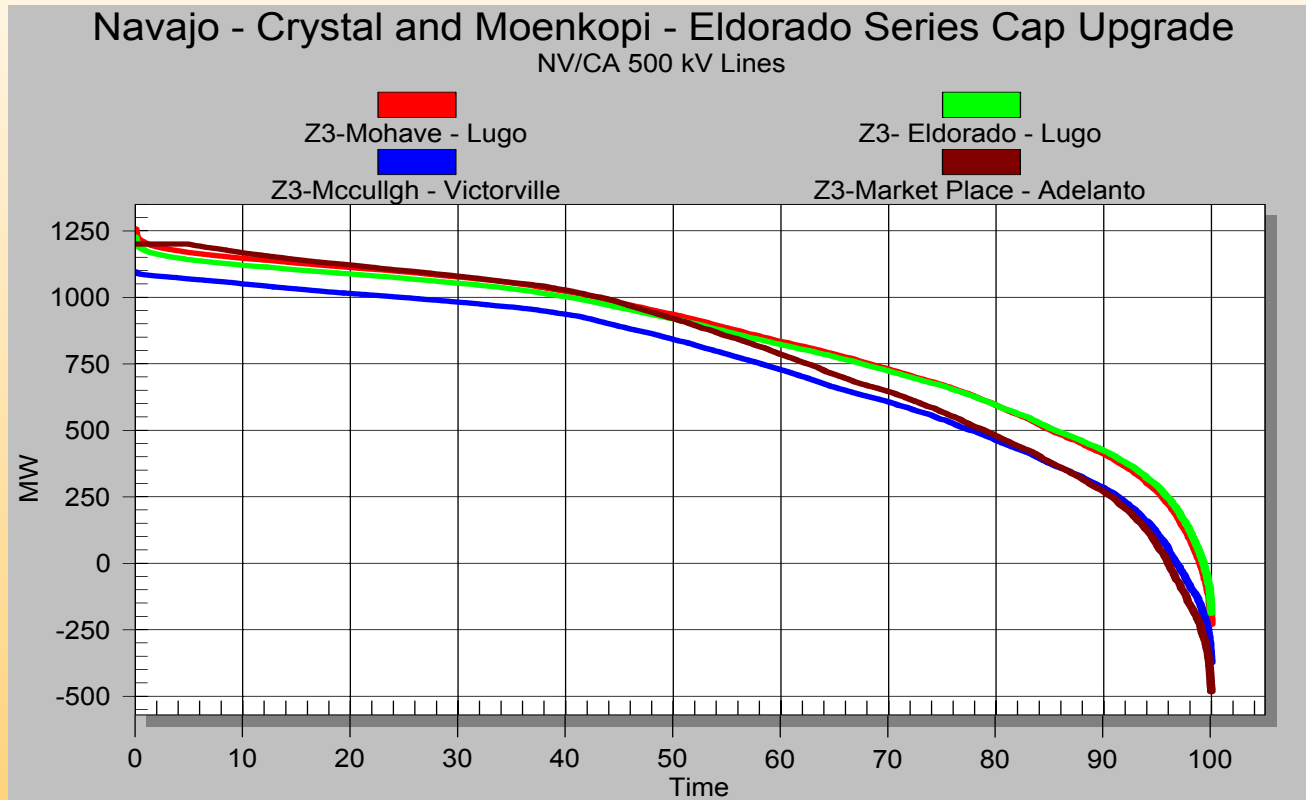


## Common Upgrades and AC 1



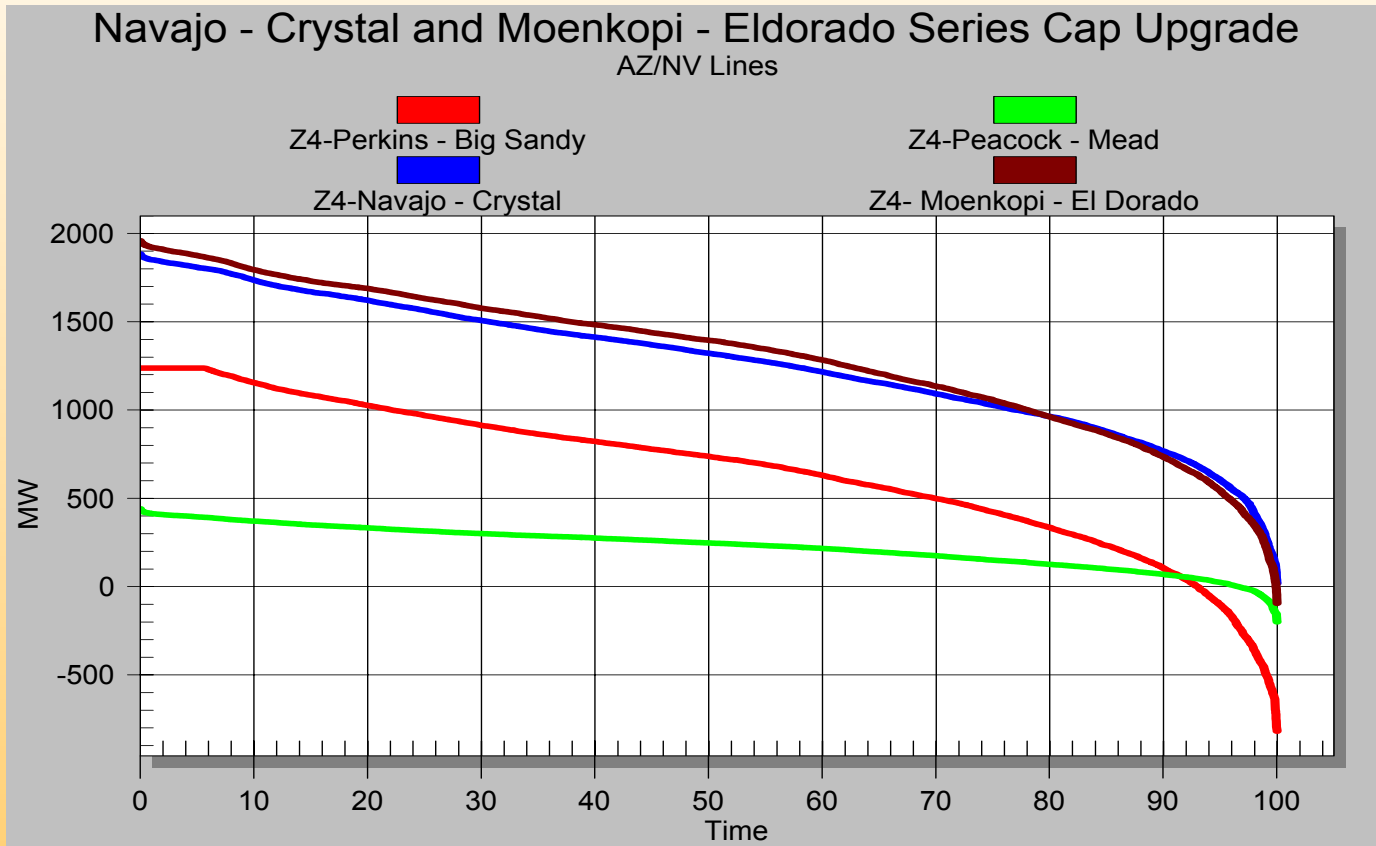


## Common Upgrades and AC 1



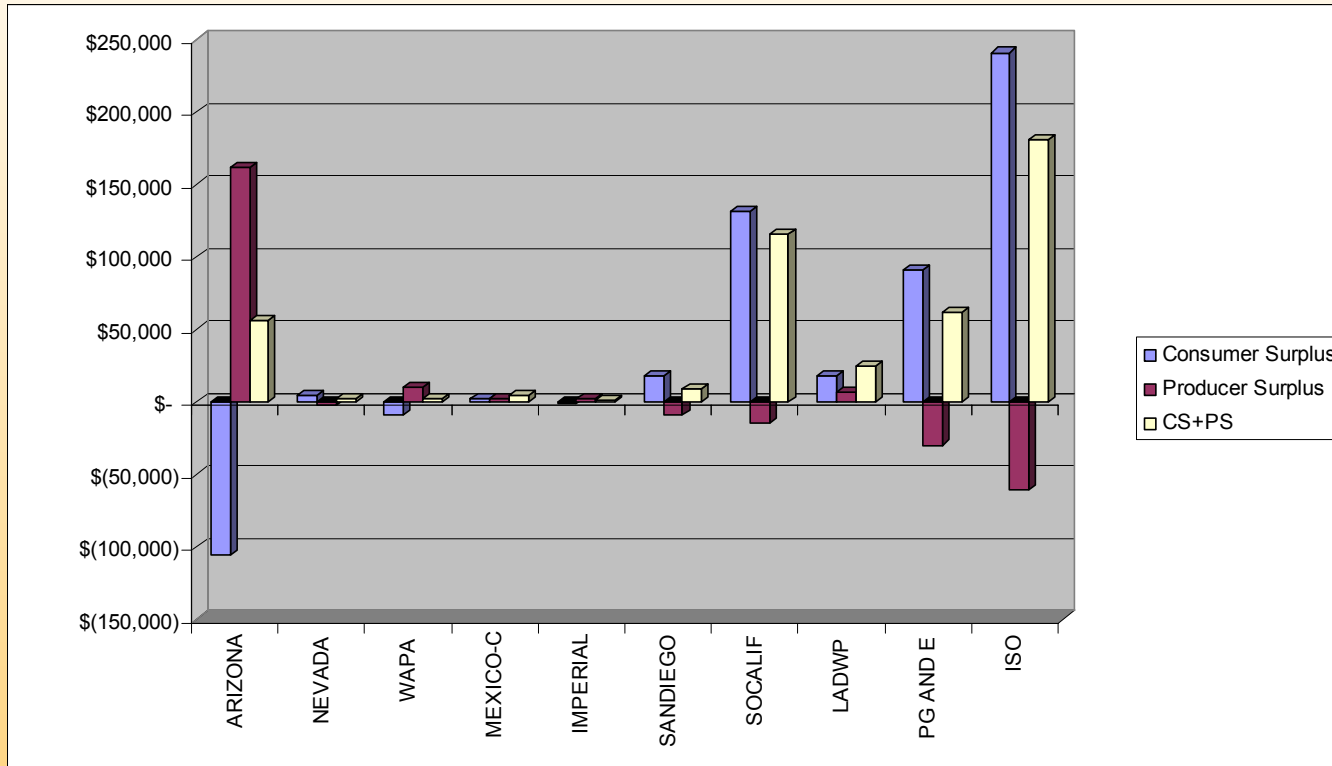


## Common Upgrades and AC 1





## Accumulative Benefits Due to Common Upgrades and AC 1

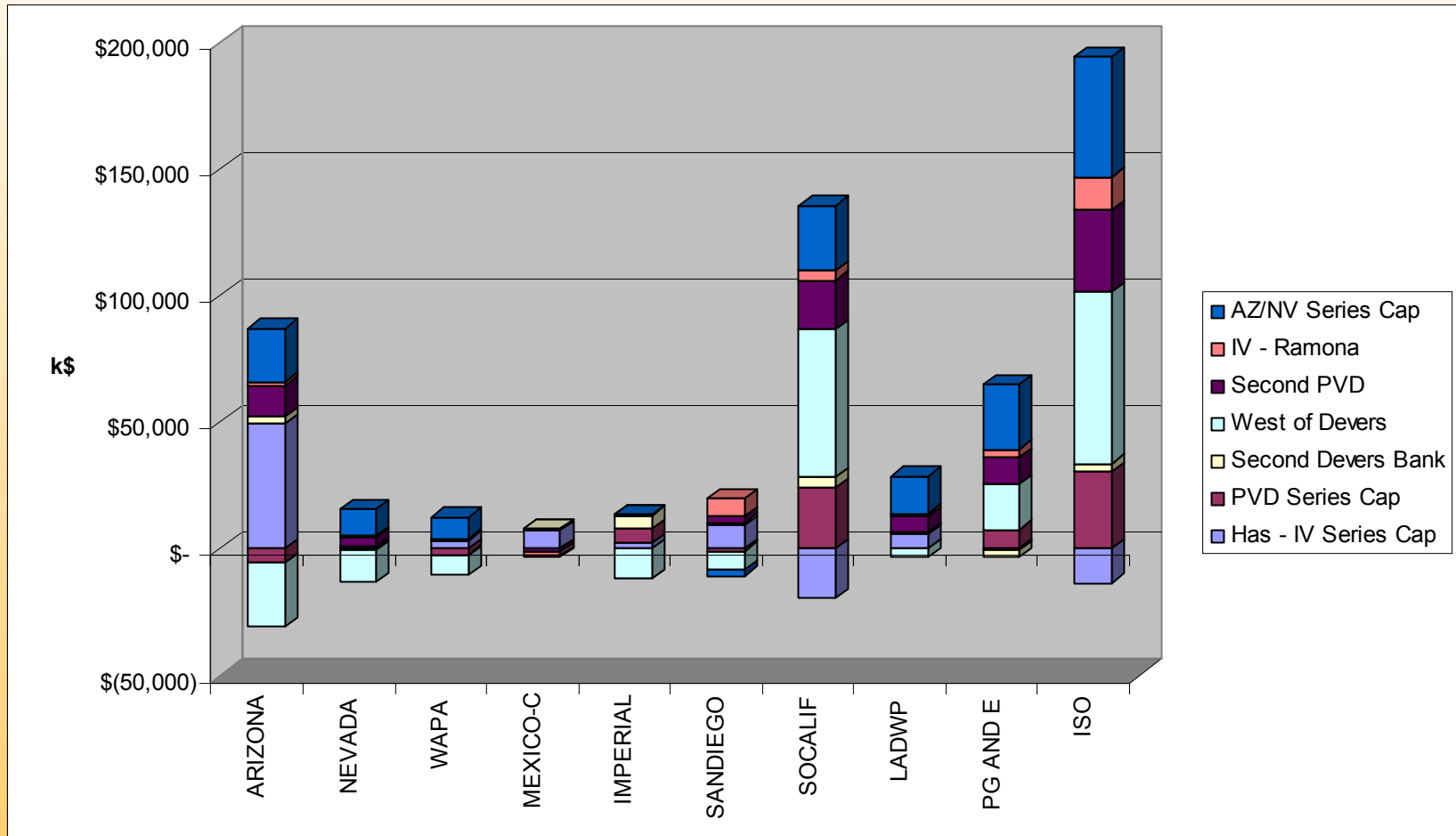


**Levelized Project Cost /Year**      \$    227,318.88

CS	-\$105,744.00	\$4,817.00	-\$8,609.00	\$1,981.00	-\$840.00	\$18,288.00	\$131,174.00	\$18,314.00	\$91,337.00	\$240,799.00
PS	\$161,710.04	-\$2,240.60	\$10,488.74	\$2,691.40	\$2,270.46	-\$9,386.00	-\$15,071.59	\$6,933.79	-\$29,684.44	-\$60,170.88
CS+PS	\$55,966.04	\$2,576.40	\$1,879.74	\$4,672.40	\$1,430.46	\$8,902.00	\$116,102.41	\$25,247.79	\$61,652.56	\$180,628.12

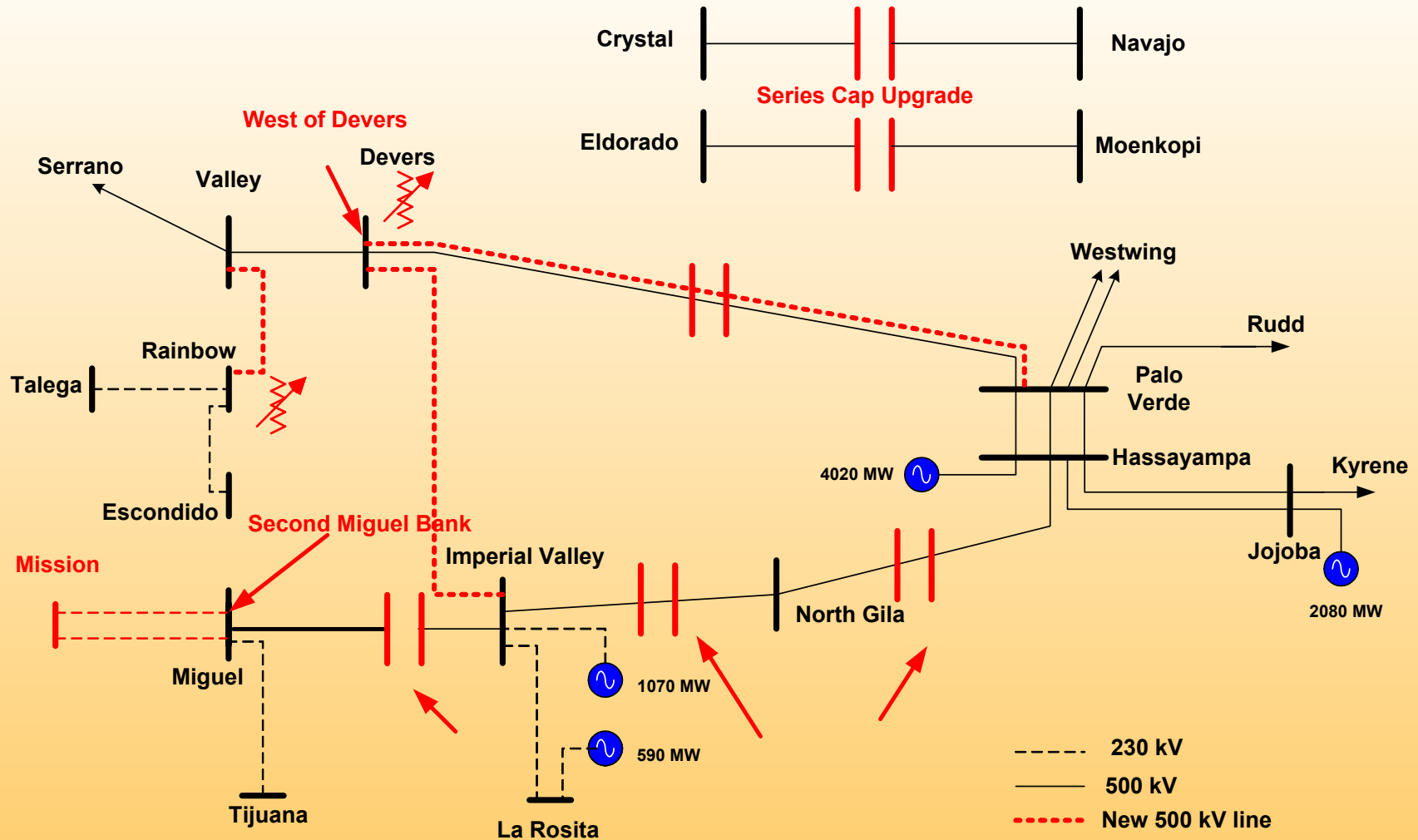


## Accumulative Benefits Due to Common Upgrades and AC 1



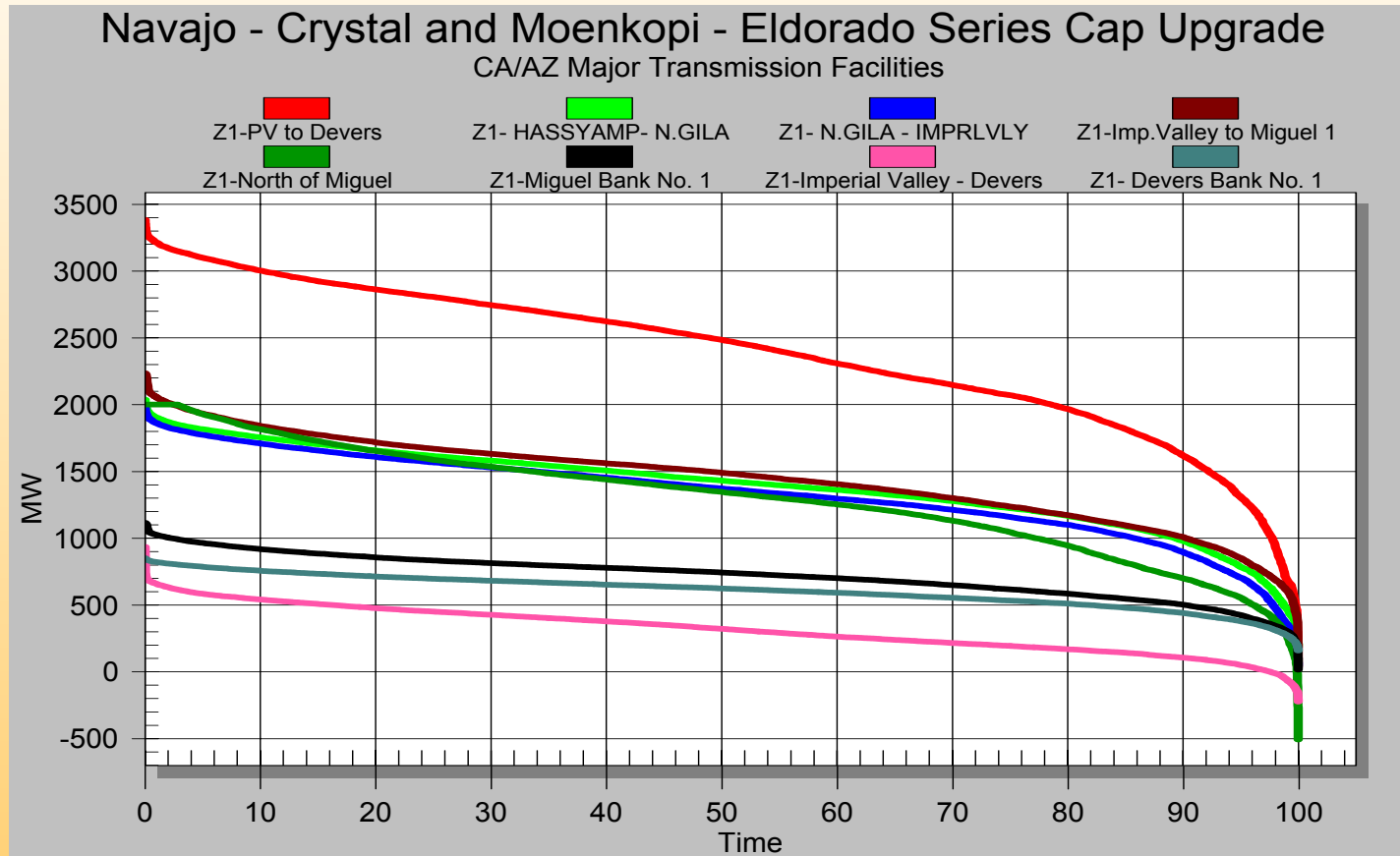


## Common Upgrades and AC 2



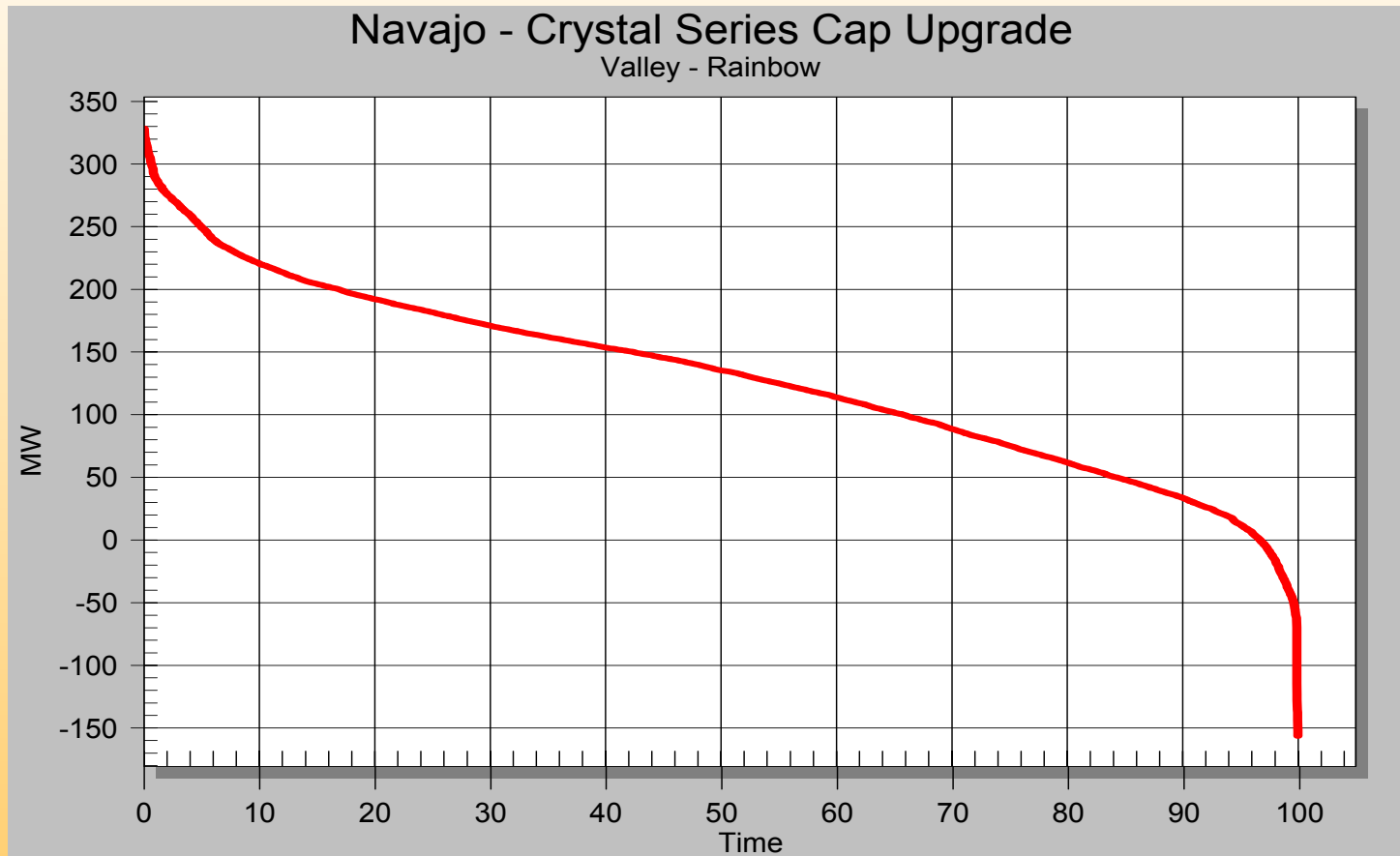


## Common Upgrades and AC 2



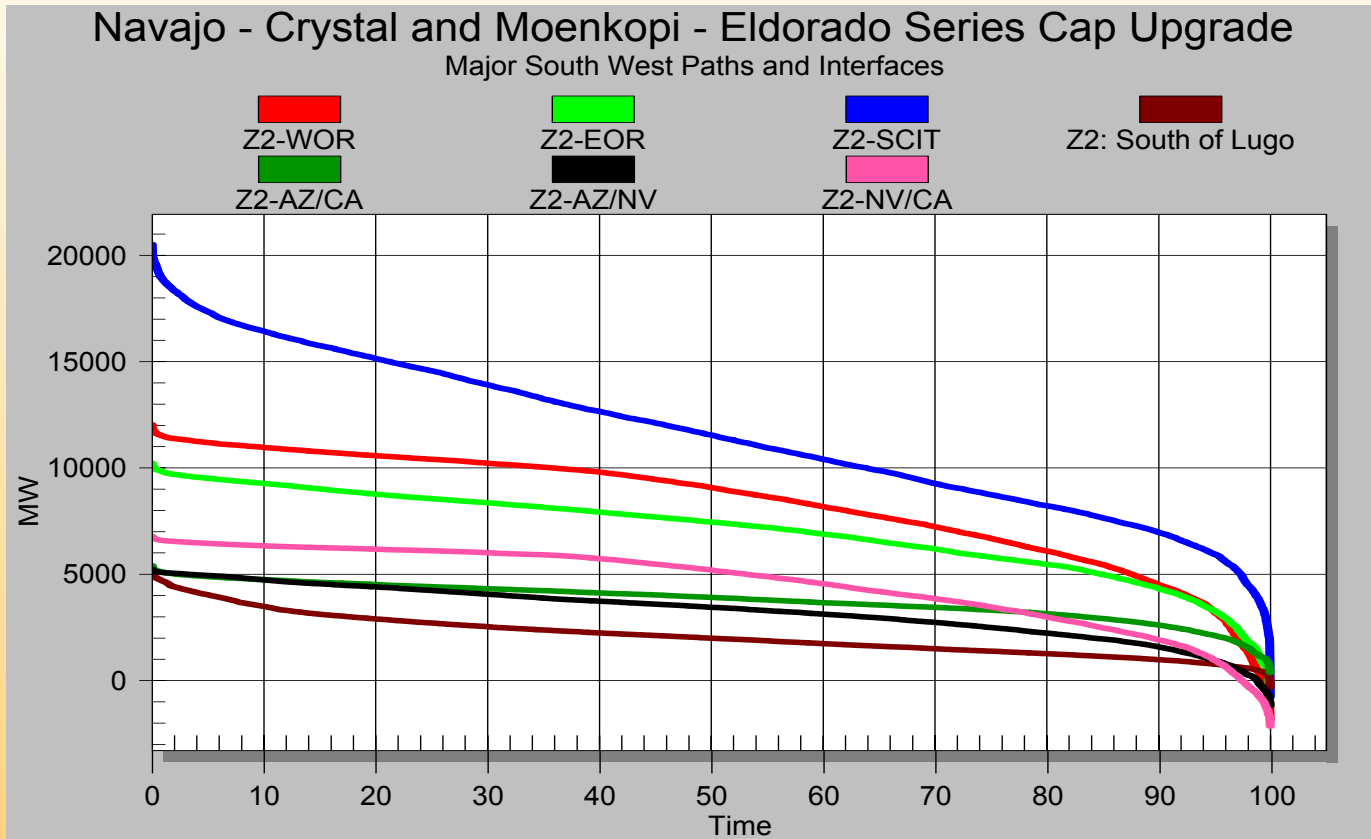


## Common Upgrades and AC 2



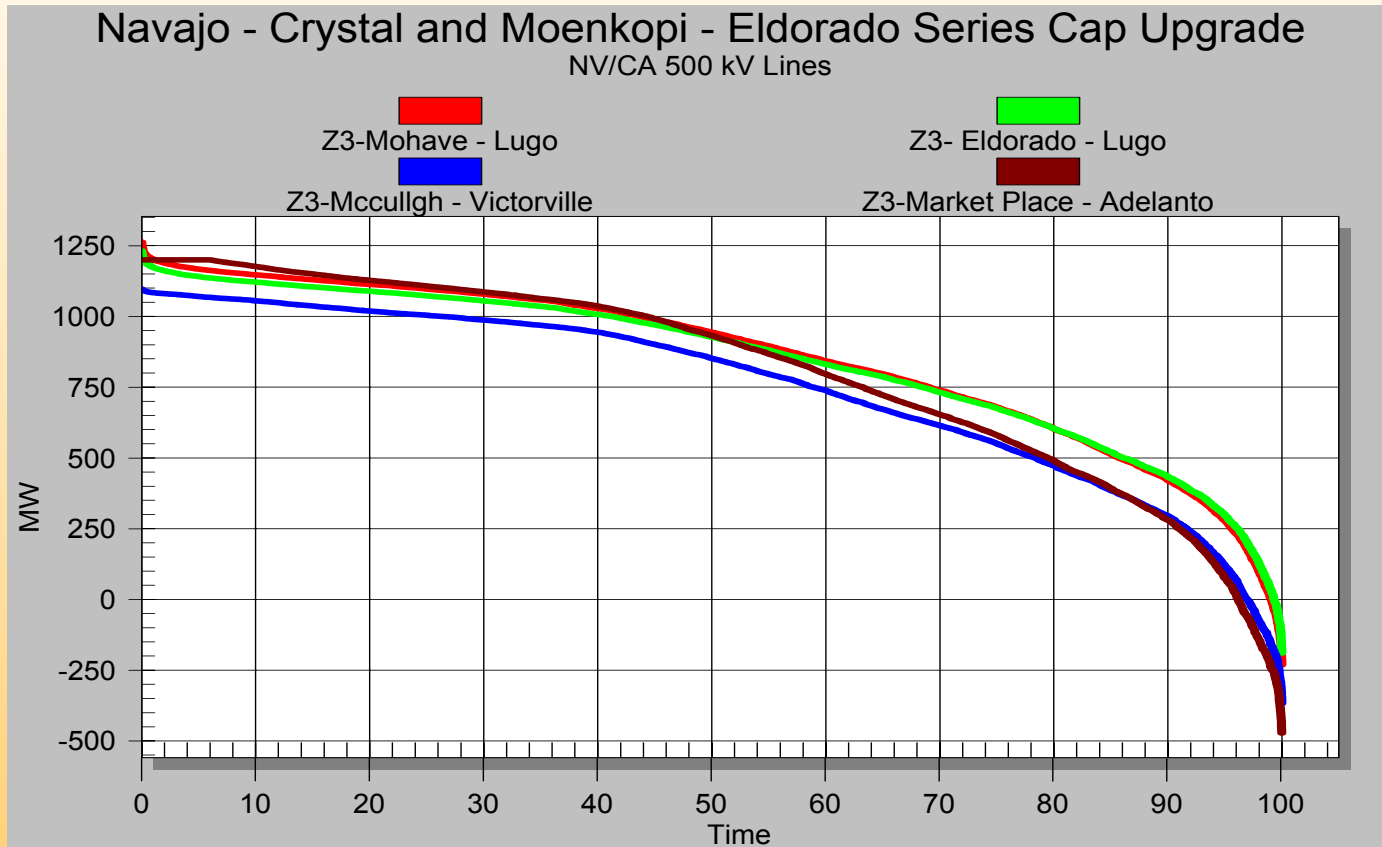


## Common Upgrades and AC 2



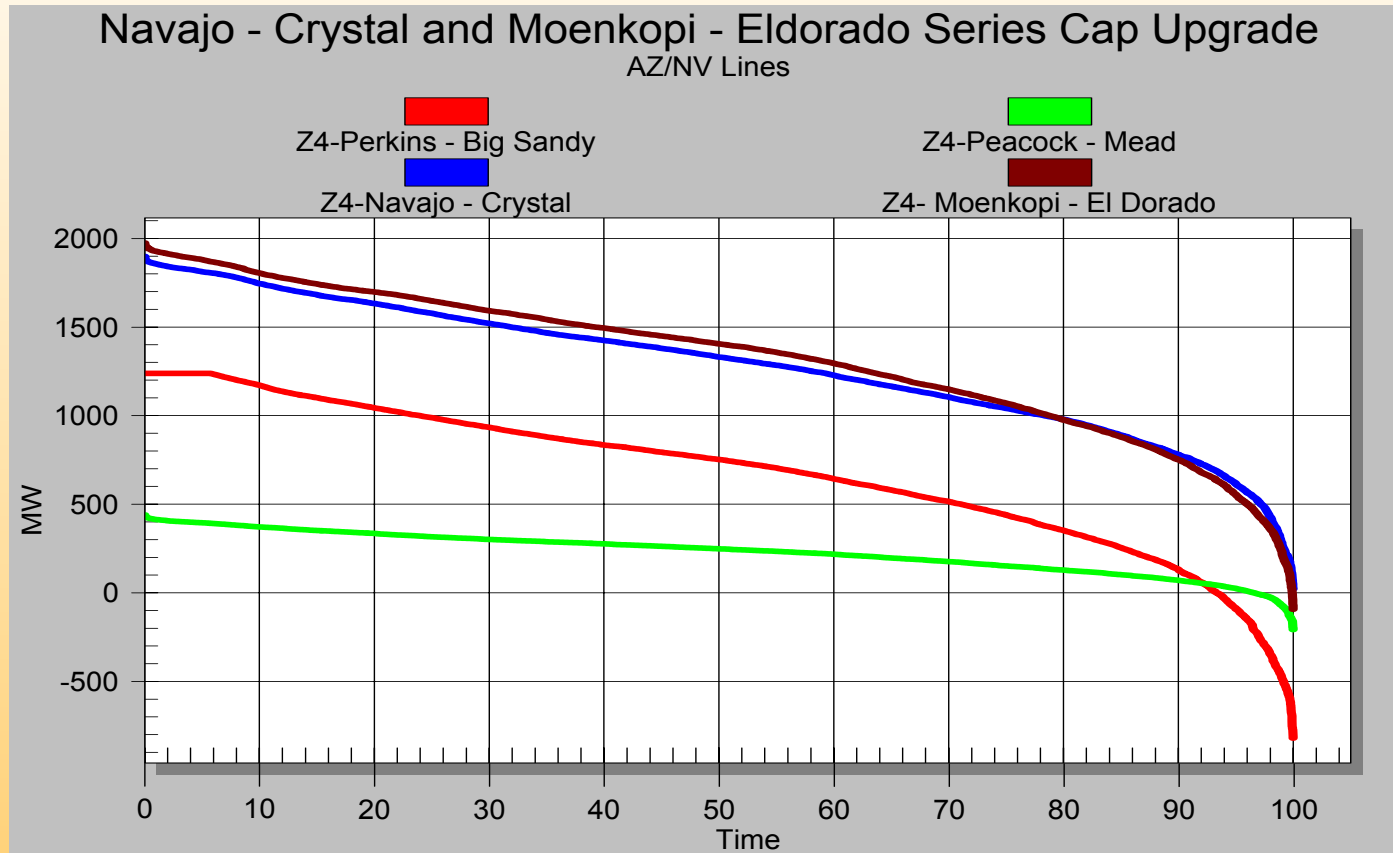


## Common Upgrades and AC 2



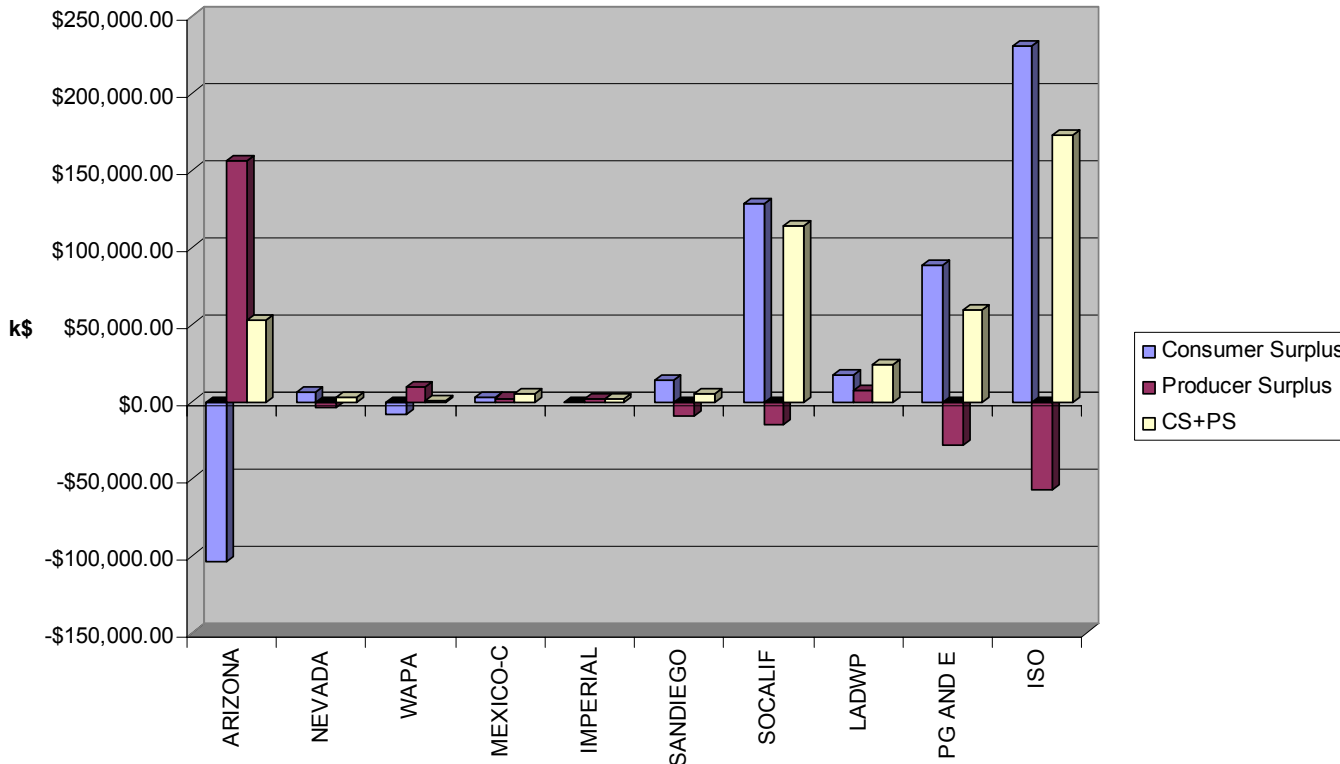


## Common Upgrades and AC 2





## Accumulative Benefits Due to Common Upgrades and AC 2

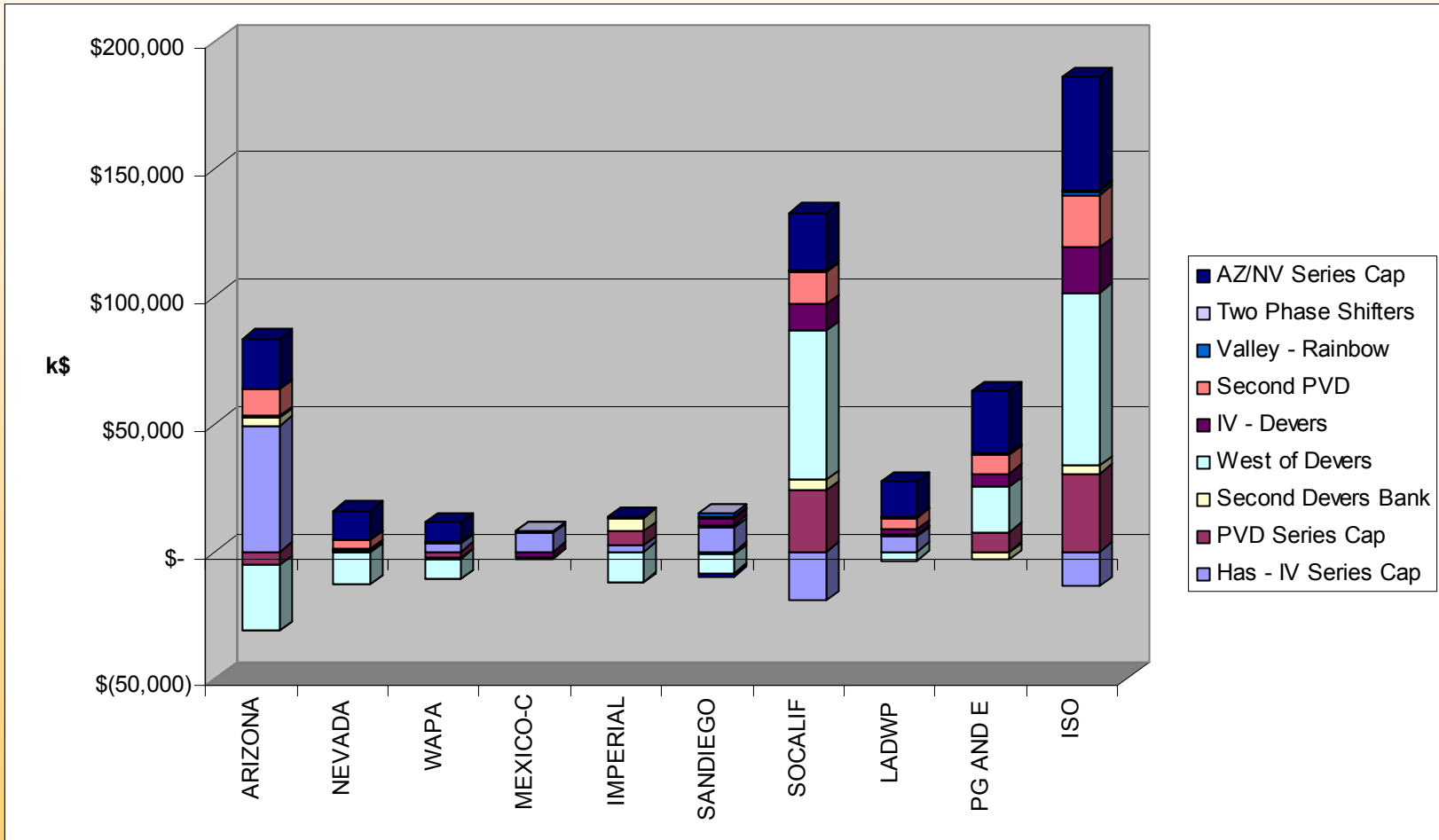


<b>Levelized Project Cost /Year</b>	<b>\$ 292,181.60</b>
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	ARIZONA	NEVADA	WAPA	MEXICO-C	IMPERIAL	SANDIEGO	SOCALIF	LADWP	PG AND E	ISO
<b>CS</b>	<b>-\$103,485.00</b>	<b>\$6,392.00</b>	<b>-\$8,451.00</b>	<b>\$2,598.00</b>	<b>-\$685.00</b>	<b>\$14,187.00</b>	<b>\$127,946.00</b>	<b>\$16,715.00</b>	<b>\$87,832.00</b>	<b>\$229,965.00</b>
<b>PS</b>	<b>\$155,852.91</b>	<b>-\$3,511.80</b>	<b>\$9,001.90</b>	<b>\$2,289.90</b>	<b>\$2,166.89</b>	<b>-\$9,053.10</b>	<b>-\$14,639.25</b>	<b>\$7,025.40</b>	<b>-\$28,171.26</b>	<b>-\$57,520.67</b>
<b>CS+PS</b>	<b>\$52,367.91</b>	<b>\$2,880.20</b>	<b>\$550.90</b>	<b>\$4,887.90</b>	<b>\$1,481.89</b>	<b>\$5,133.90</b>	<b>\$113,306.75</b>	<b>\$23,740.40</b>	<b>\$59,660.74</b>	<b>\$172,444.33</b>

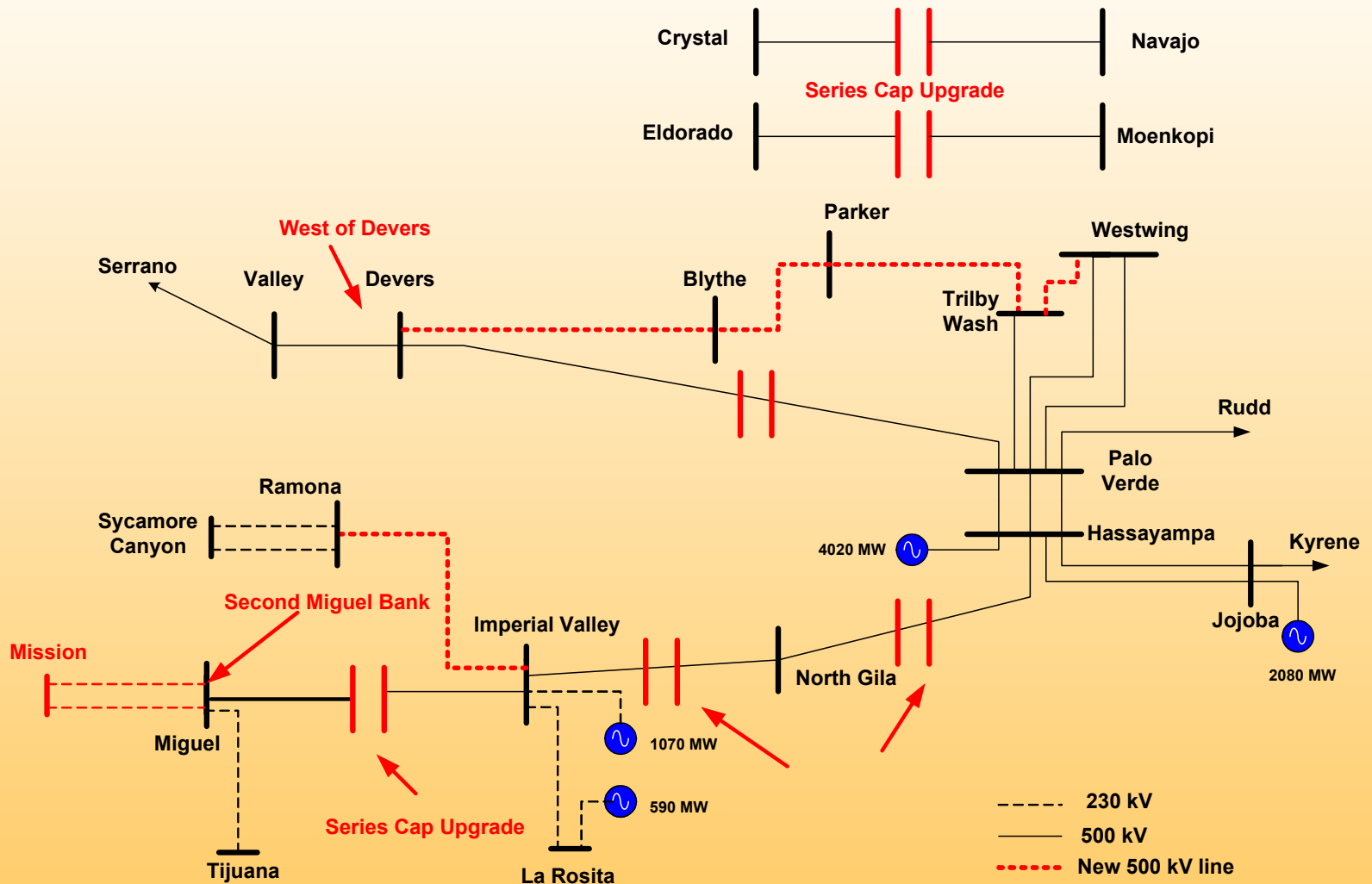


## Accumulative Benefits Due to Common Upgrades and AC 2



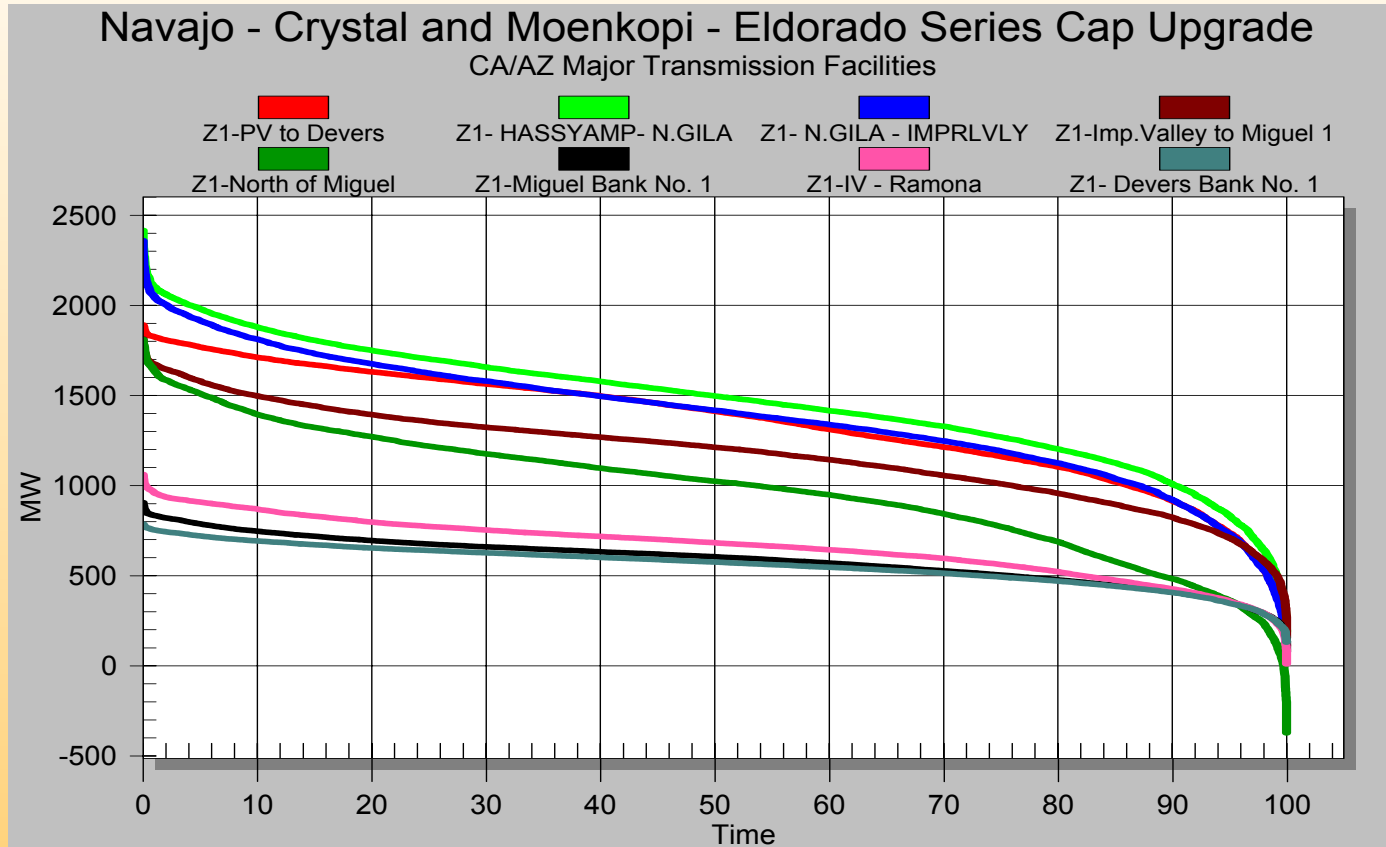


## Common Upgrades and AC 3



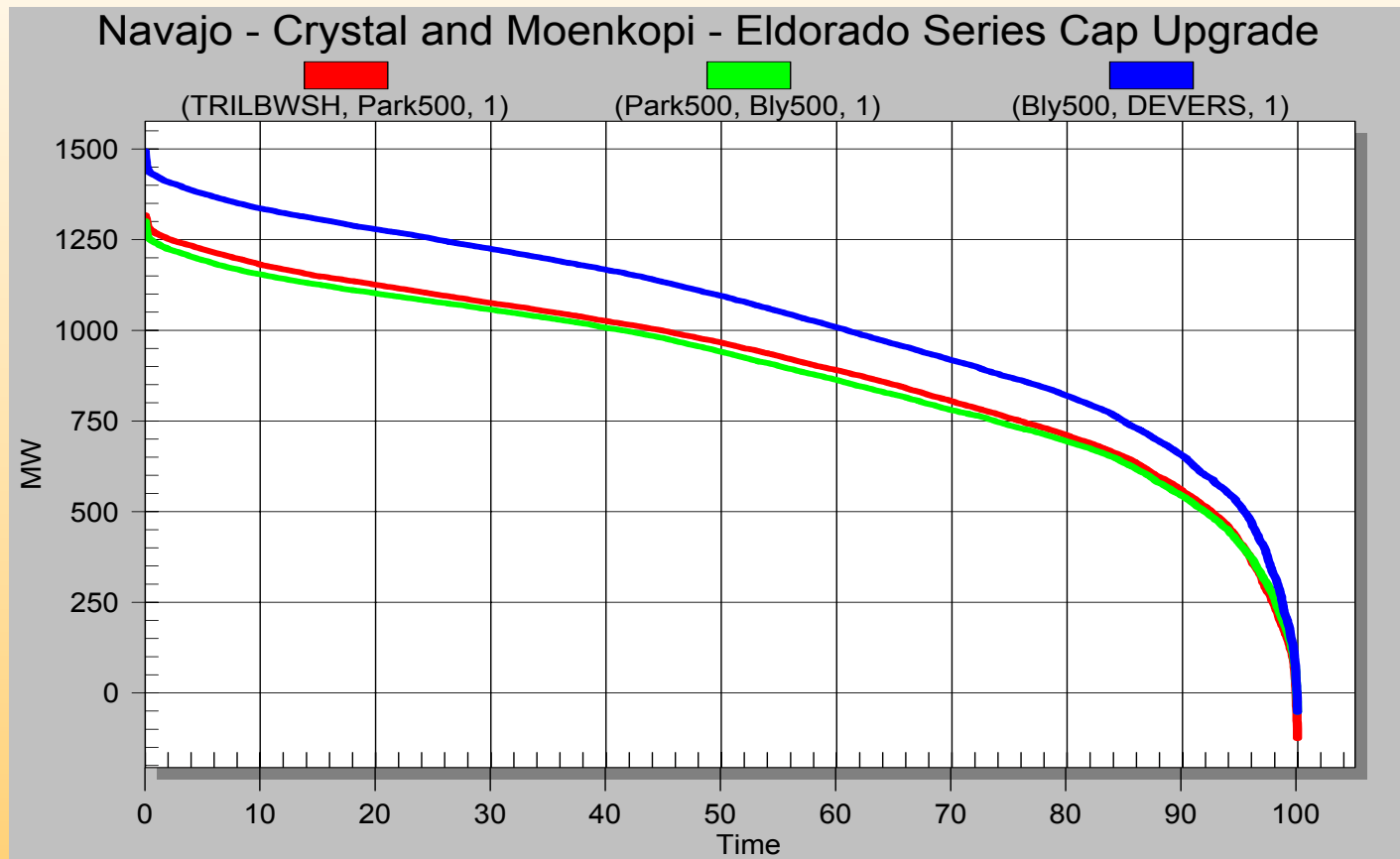


## Common Upgrades and AC 3



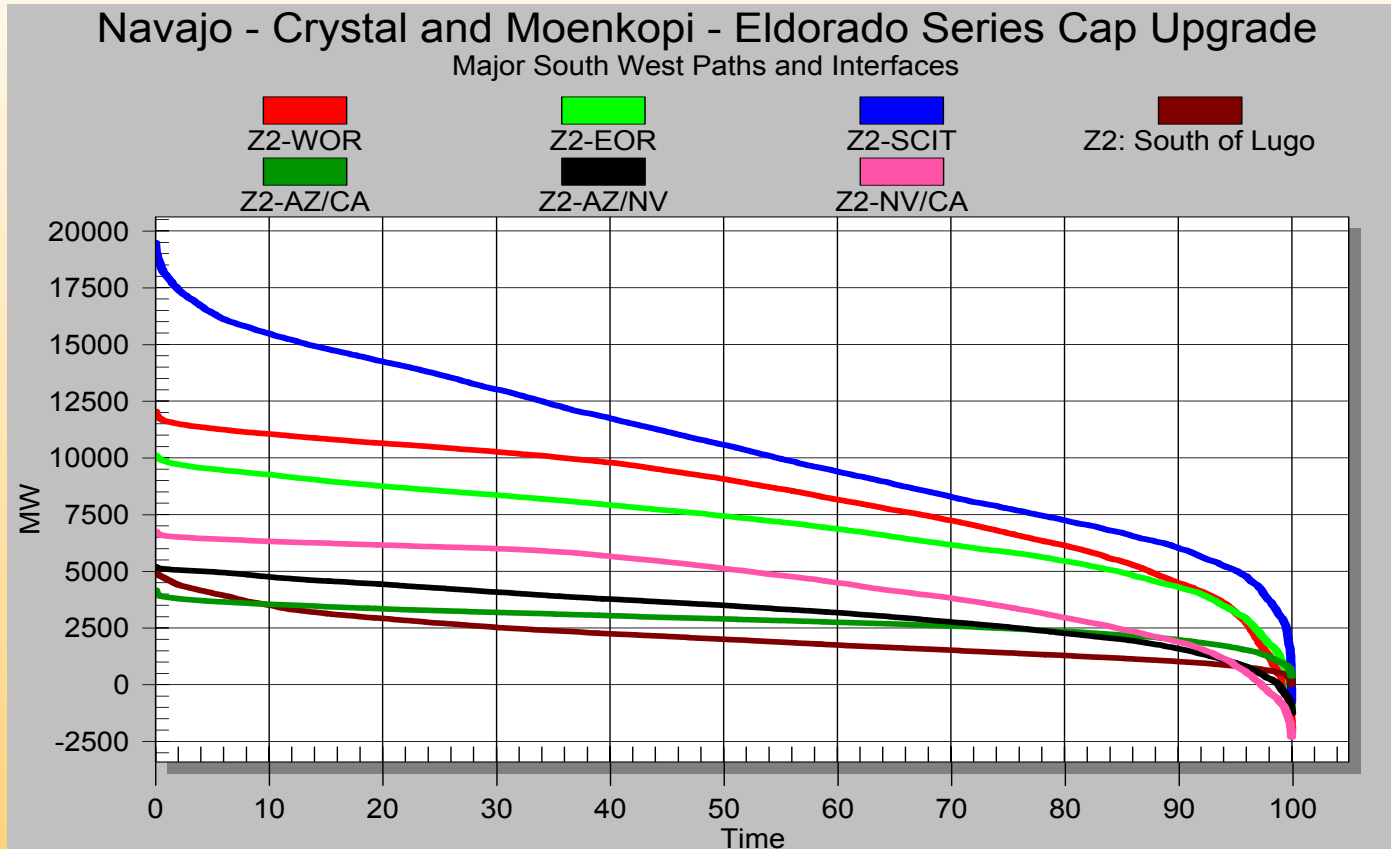


## Common Upgrades and AC 3



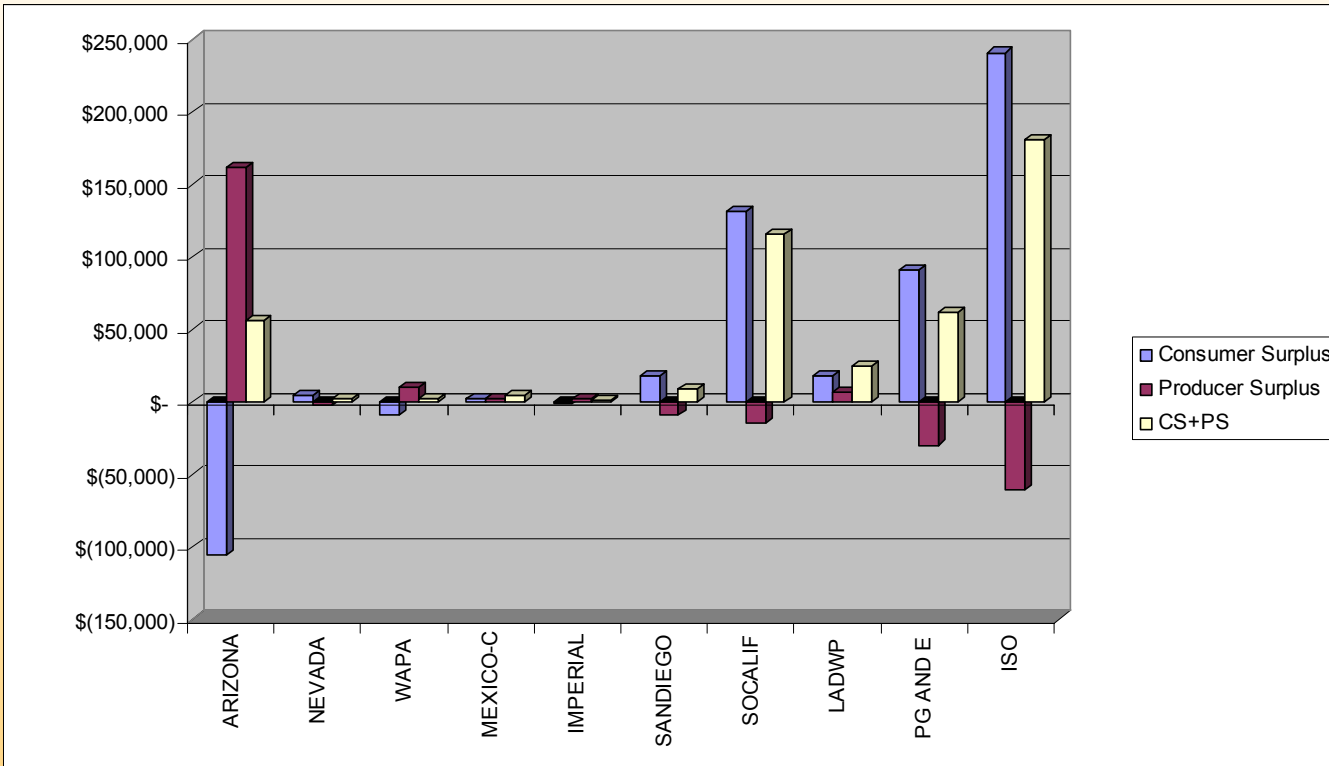


## Common Upgrades and AC 3





## Accumulative Benefits Due to Common Upgrades and AC 3

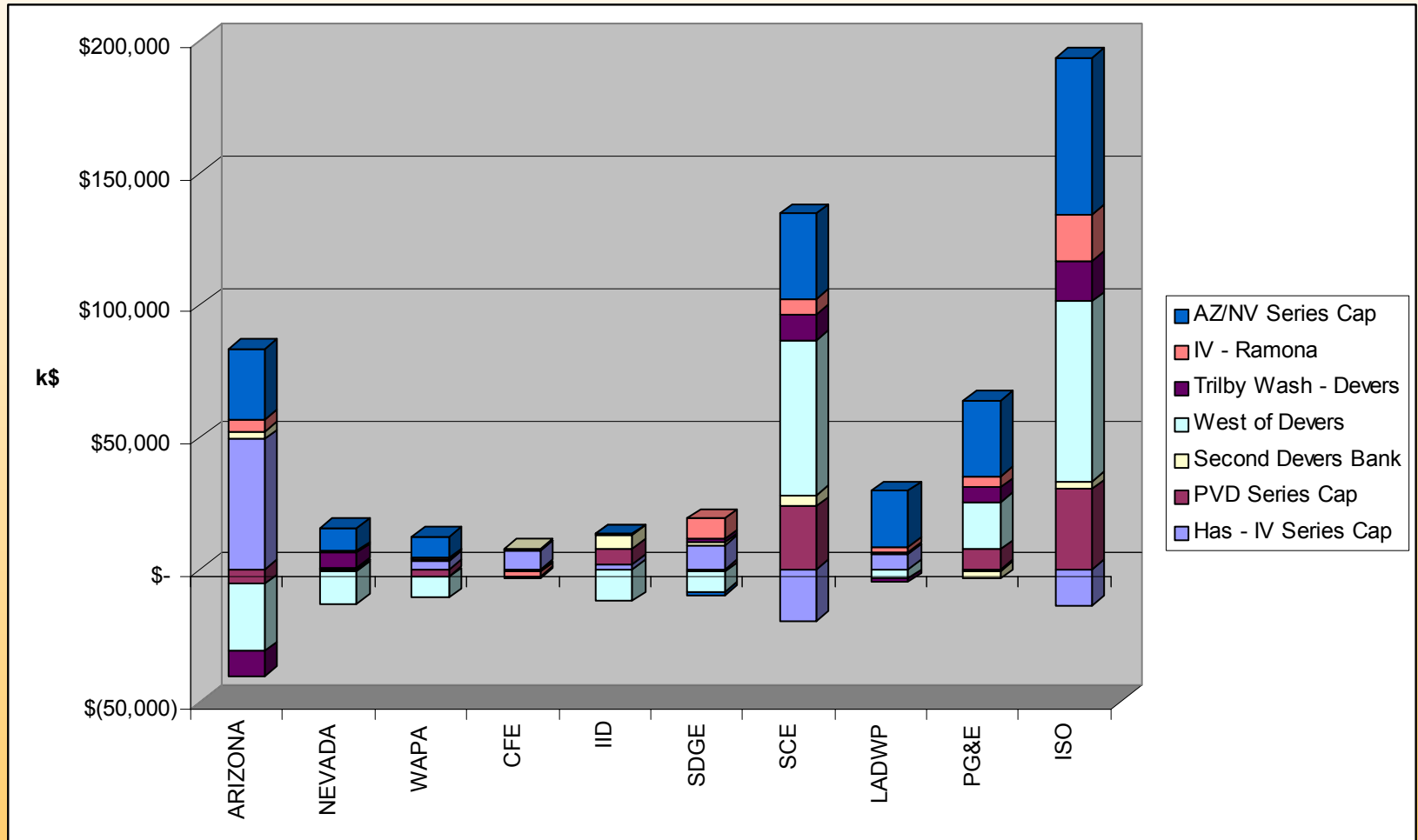


**Levelized Project Cost /Year**      \$    **265,238.63**

	ARIZONA	NEVADA	WAPA	MEXICO-C	IMPERIAL	SANDIEGO	SOCALIF	LADWP	PG AND E	ISO
CS	-\$121,300.00	\$4,556.00	-\$9,382.00	\$2,324.00	-\$637.00	\$19,255.00	\$130,473.00	\$18,222.00	\$90,235.00	\$239,963.00
PS	\$164,569.78	-\$1,732.83	\$11,456.19	\$2,481.10	\$2,267.72	-\$9,463.90	-\$15,127.93	\$6,901.62	-\$29,523.63	-\$60,066.22
CS+PS	\$43,269.78	\$2,823.17	\$2,074.19	\$4,805.10	\$1,630.72	\$9,791.10	\$115,345.07	\$25,123.62	\$60,711.37	\$179,896.78

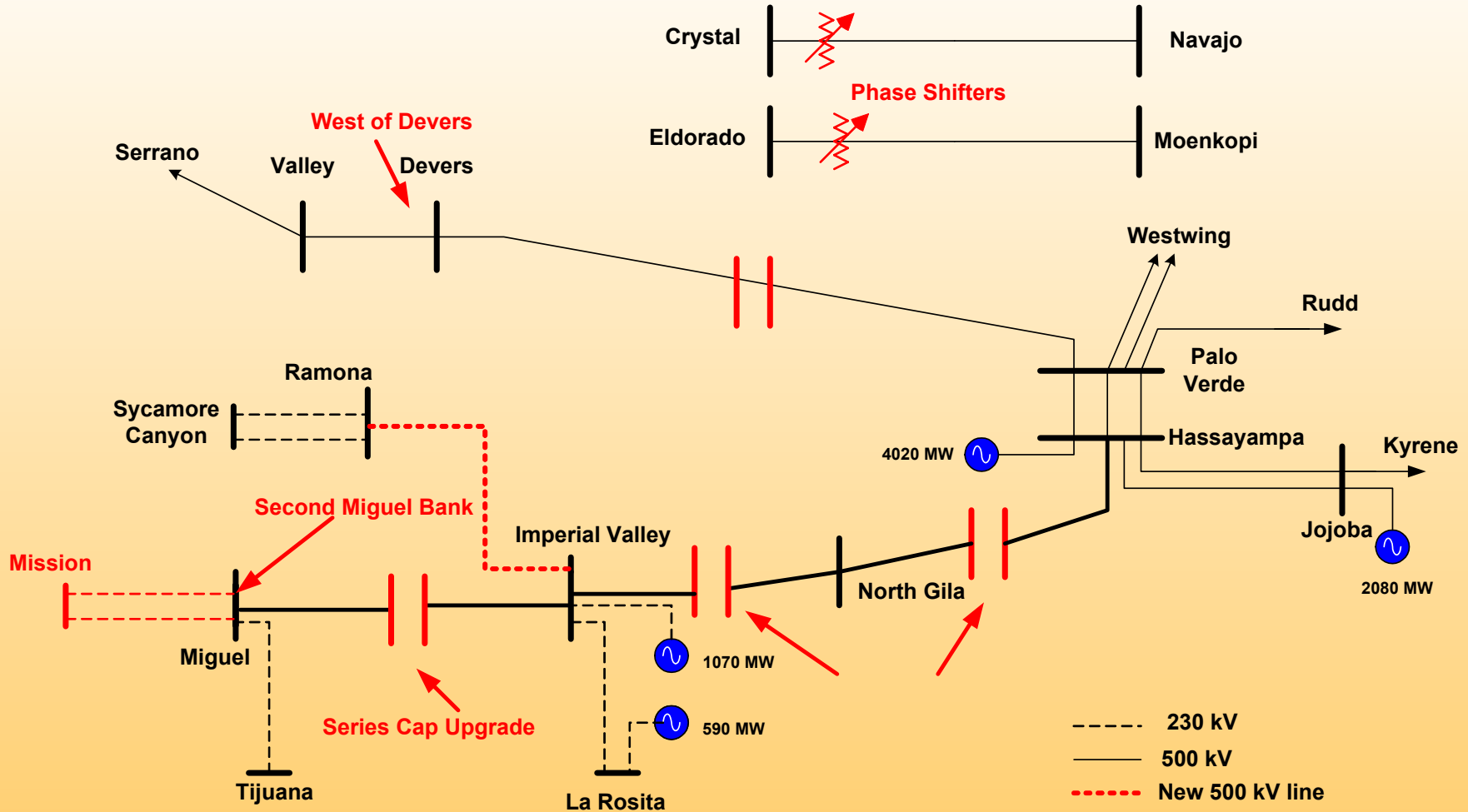


## Accumulative Benefits Due to Common Upgrades and AC 3



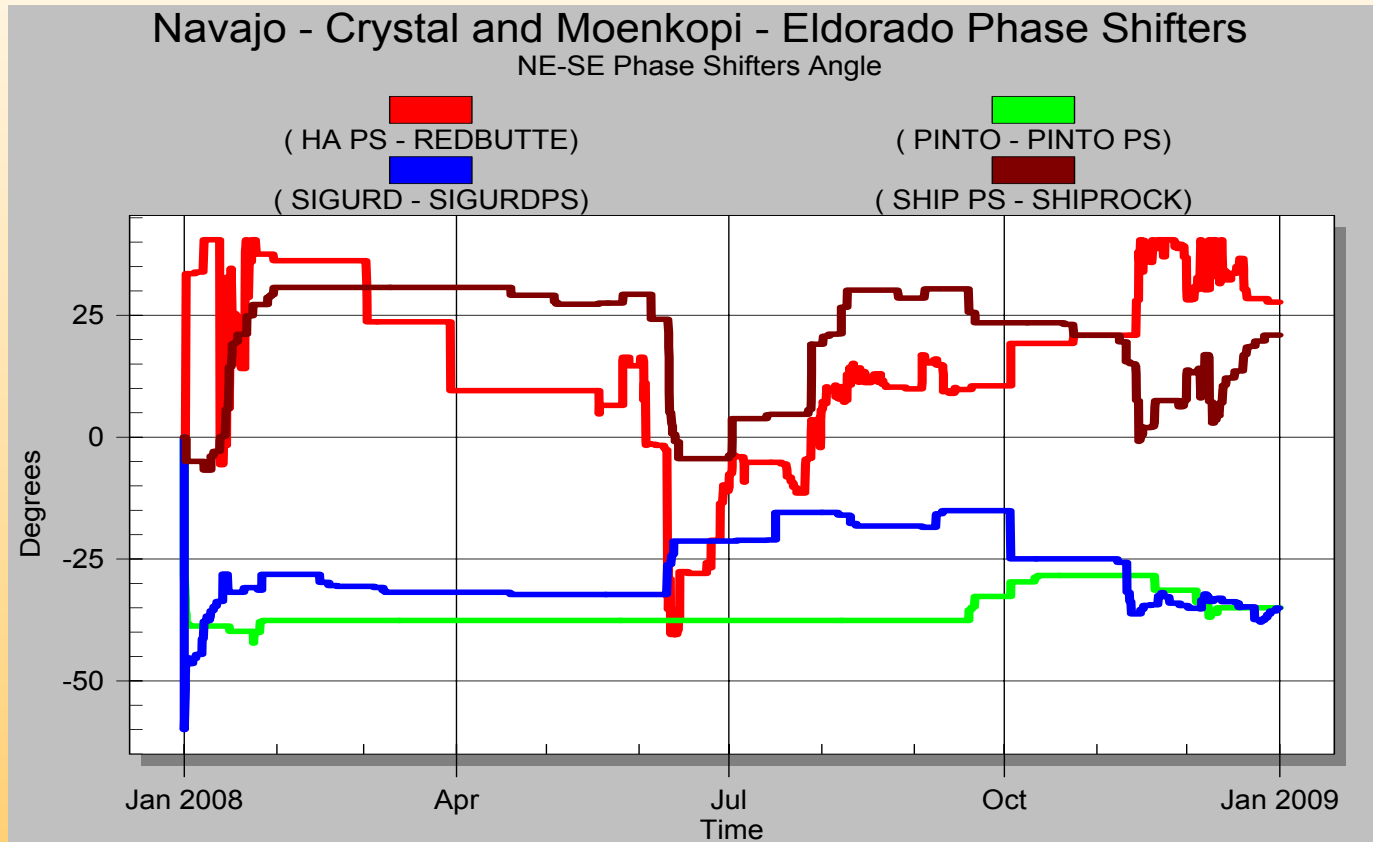


## Common Upgrades and AC 4



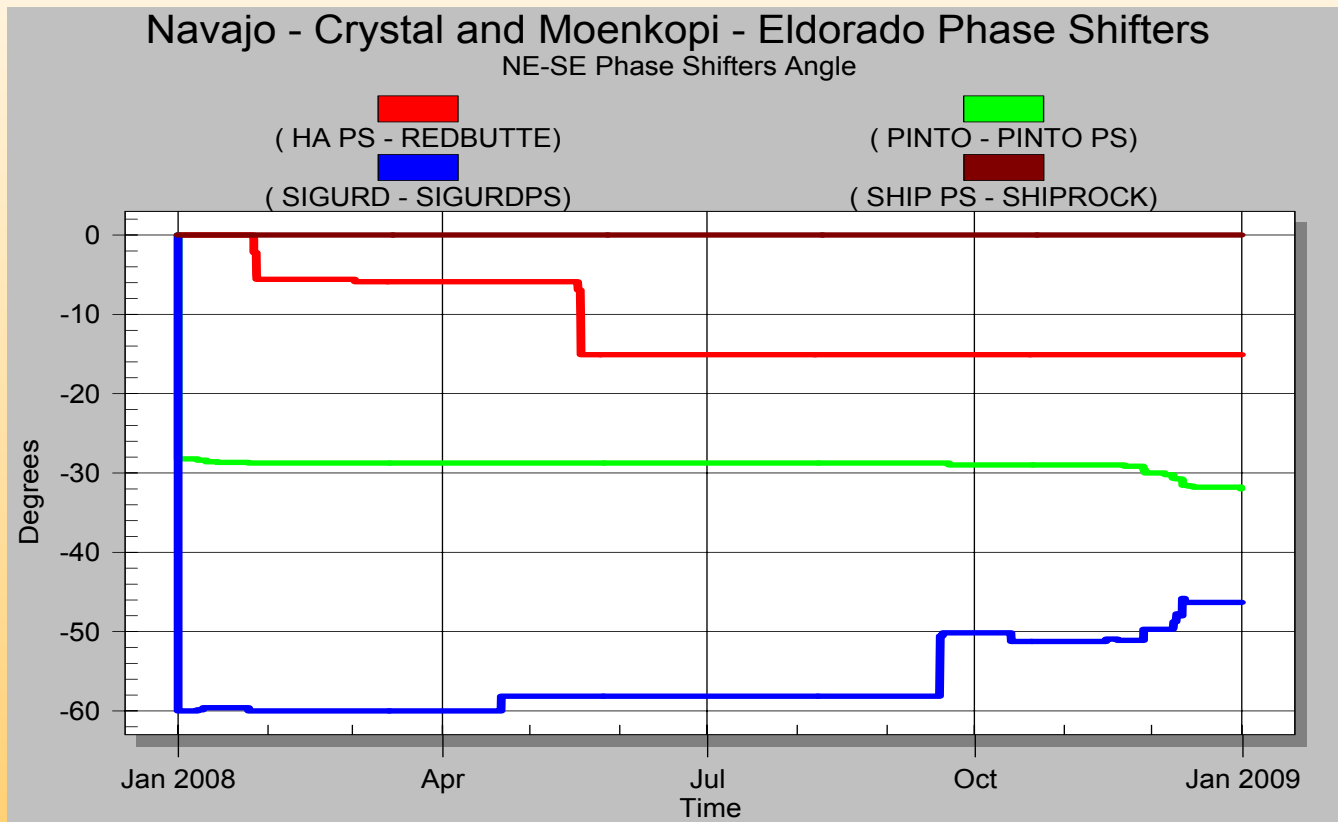


## Common Upgrades and AC 4 With \$2 Penalty



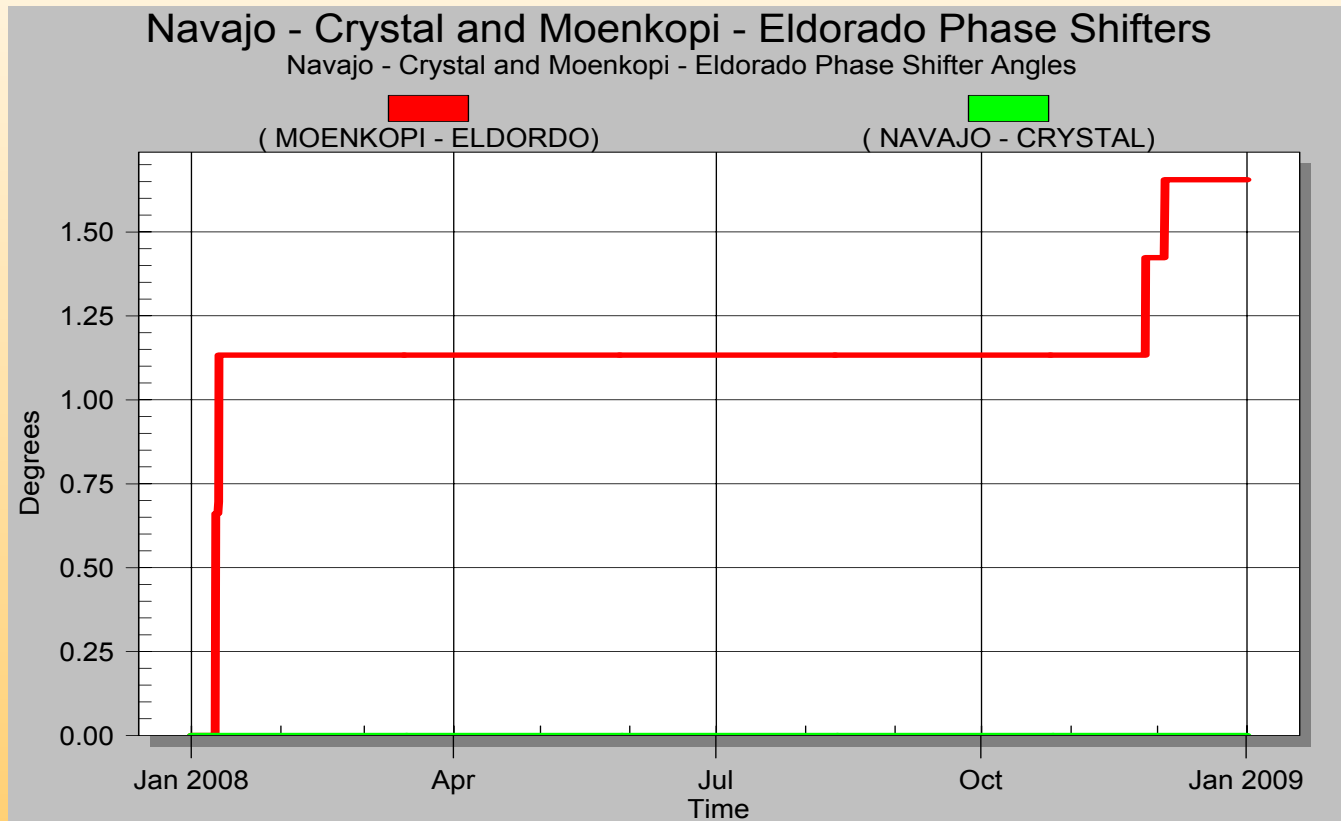


## Common Upgrades and AC 4 With \$20 Penalty



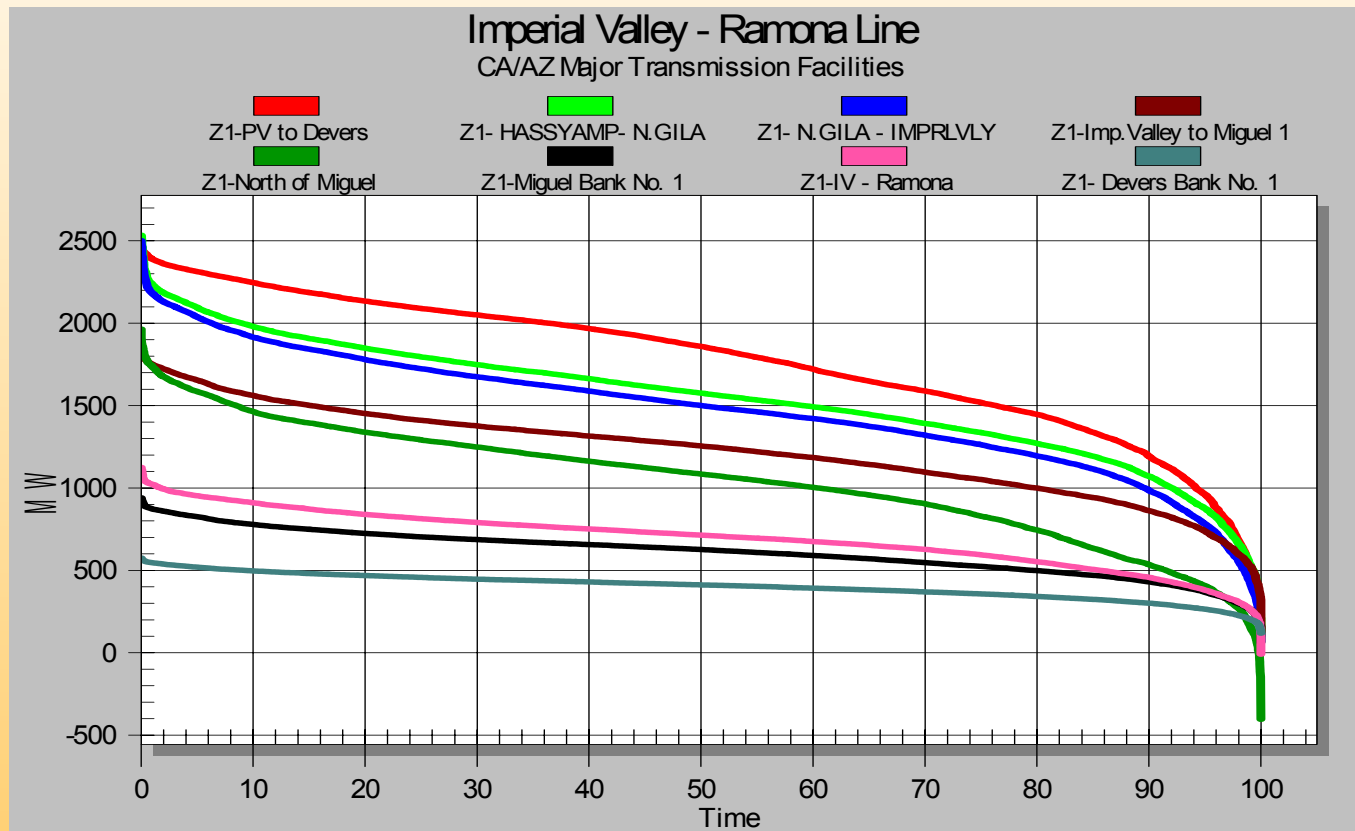


## Common Upgrades and AC 4 With \$20 Penalty



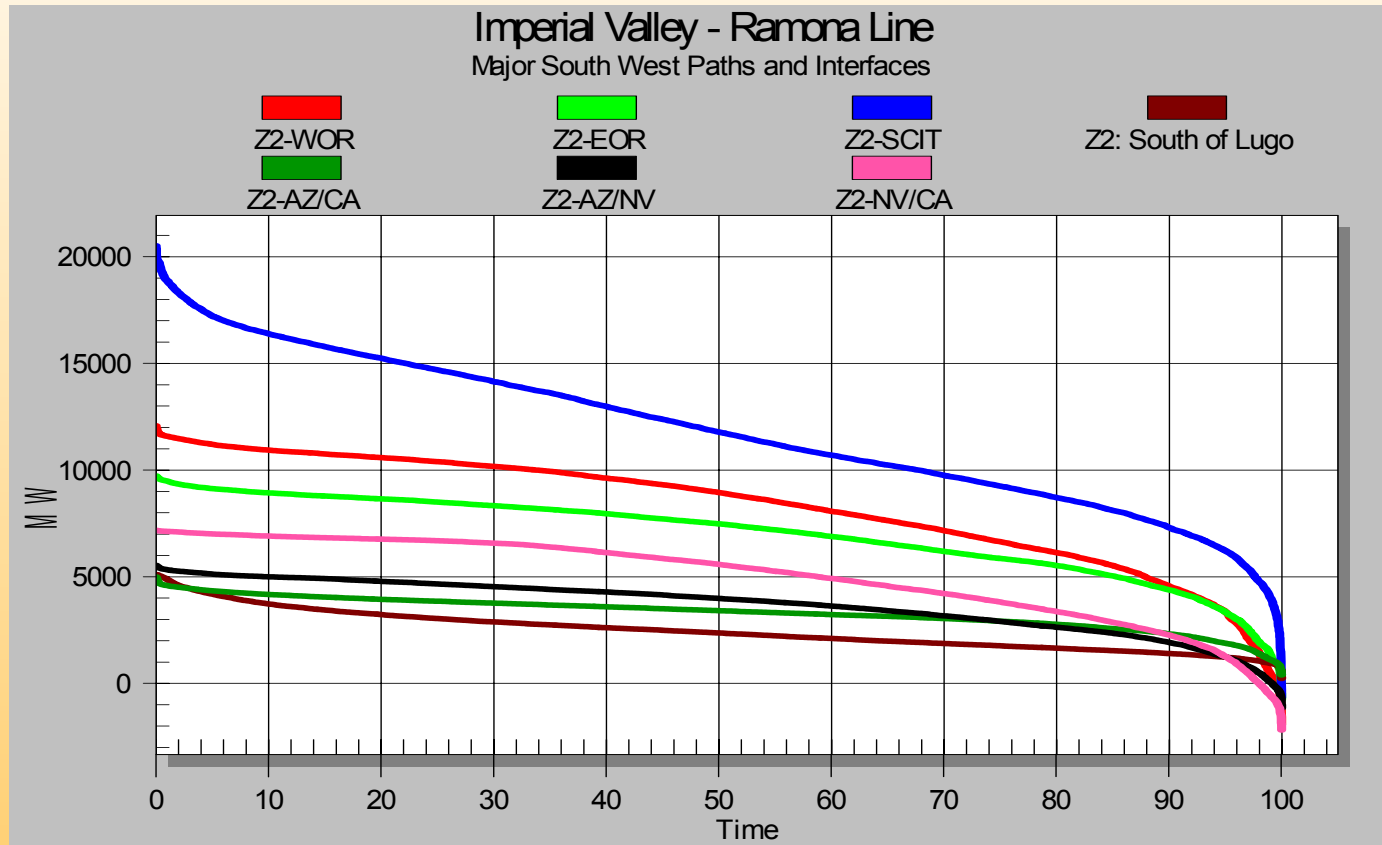


## Common Upgrades and AC 4 With \$10 Penalty



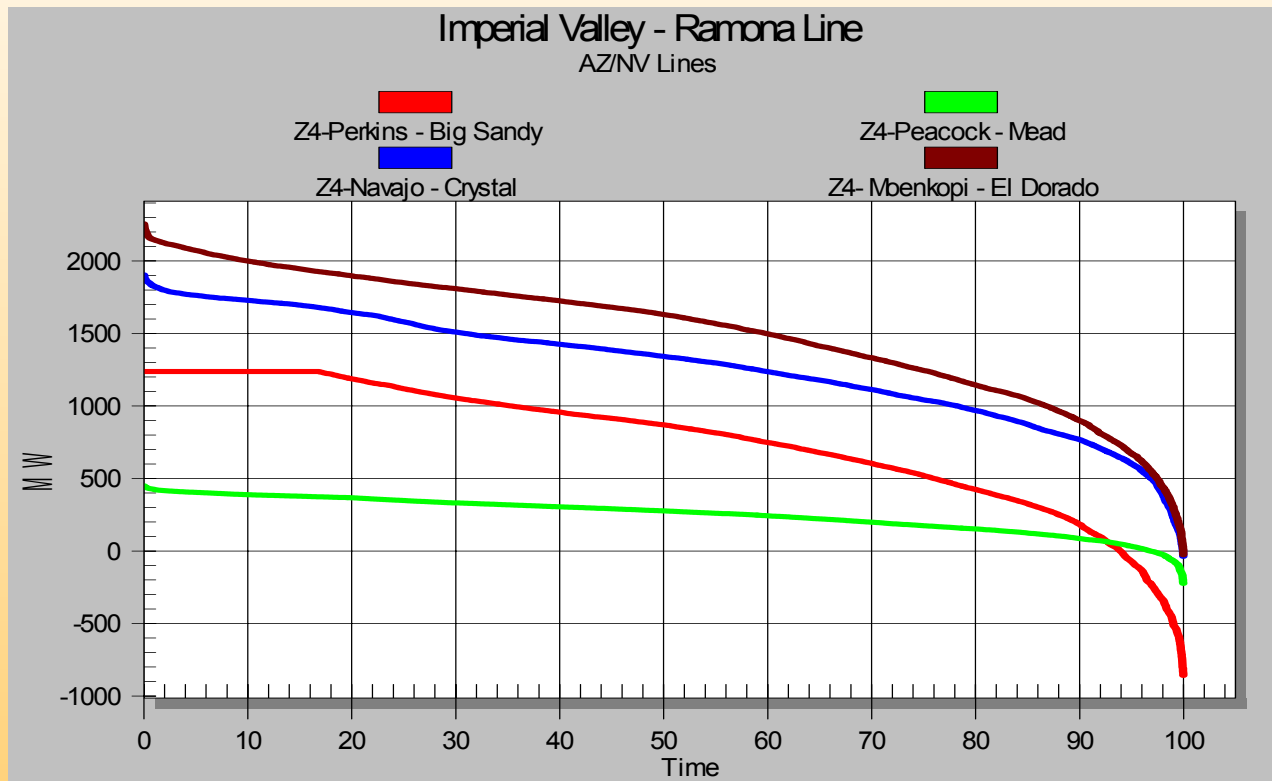


## Common Upgrades and AC 4 With \$10 Penalty



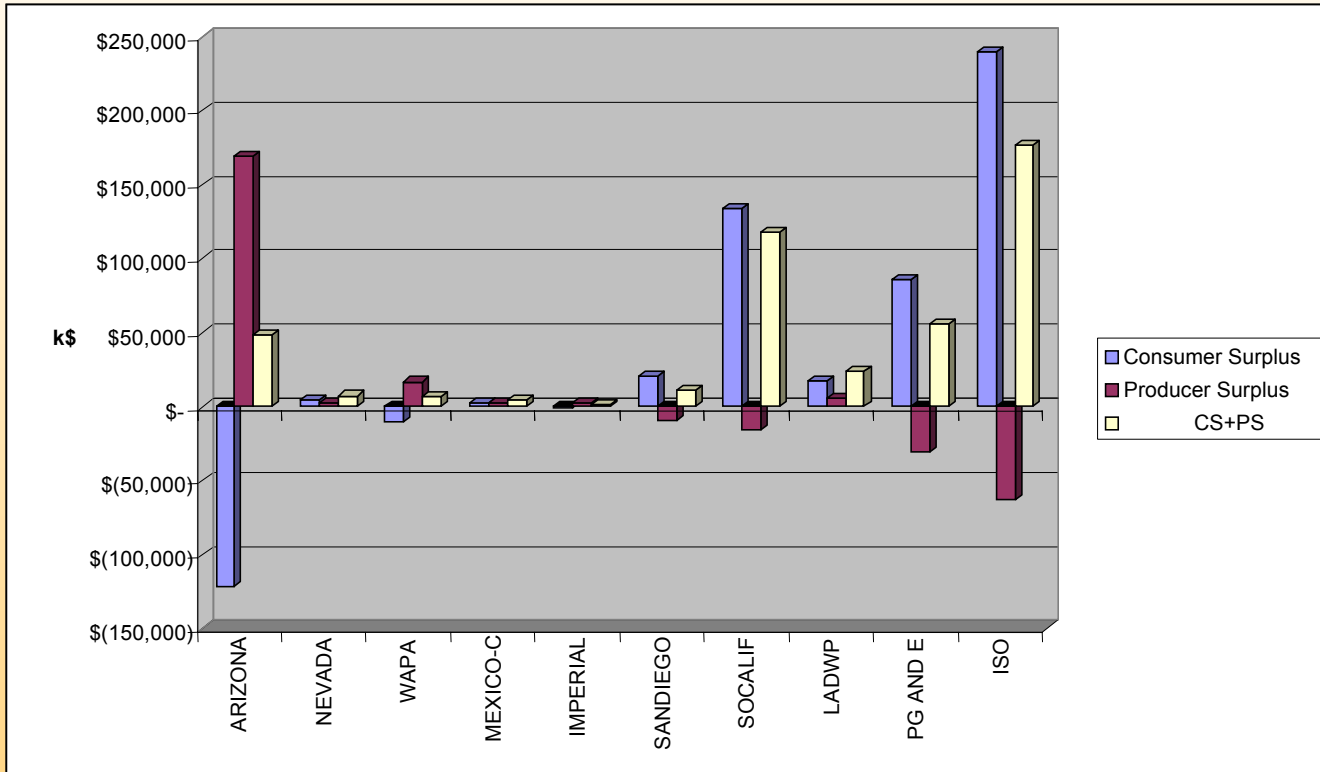


## Common Upgrades and AC 4 With \$10 Penalty





## Accumulative Benefits Due to Common Upgrades and AC 4

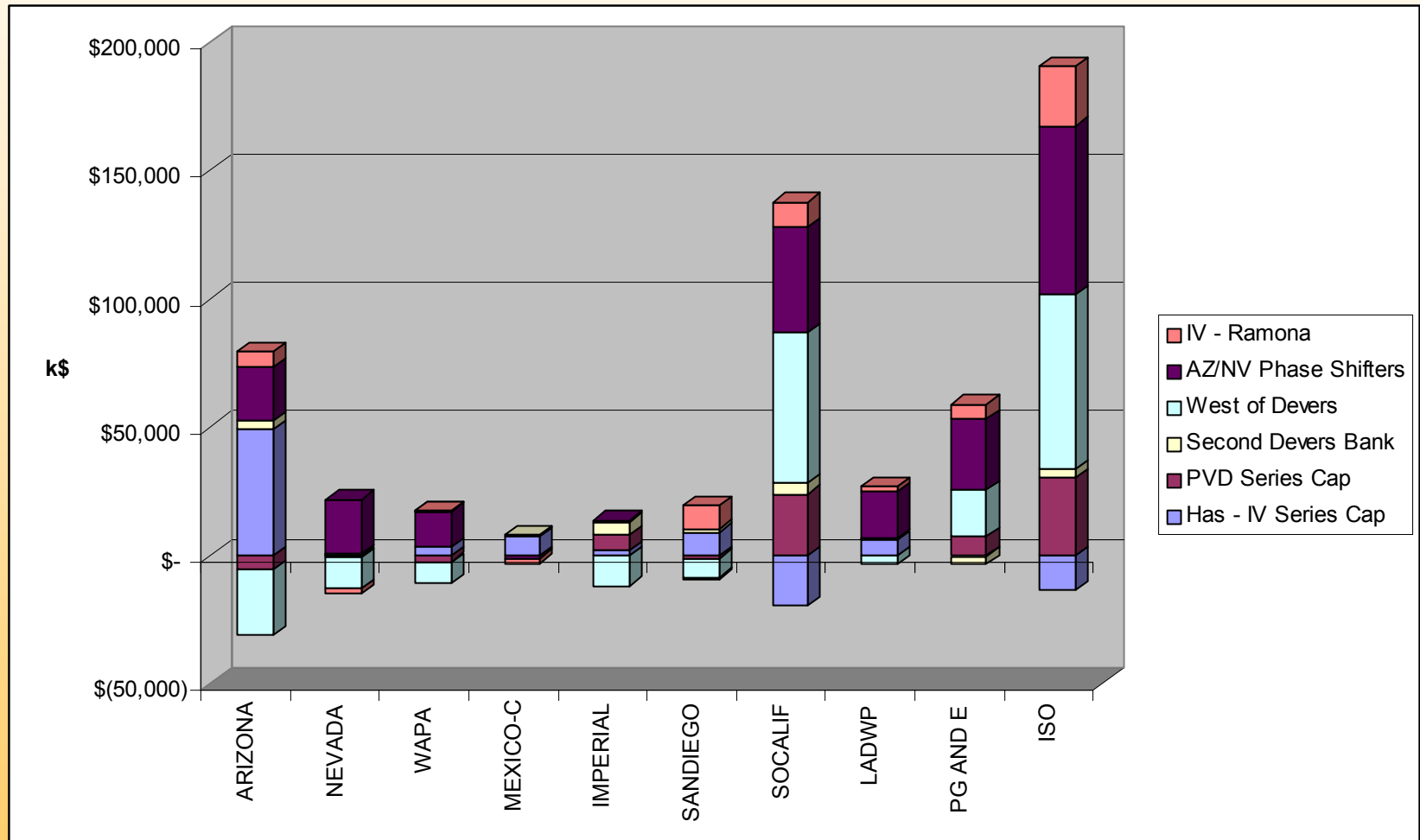


**Levelized Project Cost /Year**      \$    212,350.56

CS	-\$121,118.00	\$4,627.00	-\$10,221.00	\$2,791.00	-\$668.00	\$20,165.00	\$134,123.00	\$17,566.00	\$85,831.00	\$240,119.00
PS	\$169,551.40	\$2,603.71	\$16,877.12	\$2,158.30	\$2,281.57	-\$9,608.70	-\$15,966.55	\$6,097.56	-\$30,270.30	-\$63,199.76
CS+PS	\$48,433.40	\$7,230.71	\$6,656.12	\$4,949.30	\$1,613.57	\$10,556.30	\$118,156.45	\$23,663.56	\$55,560.70	\$176,919.24

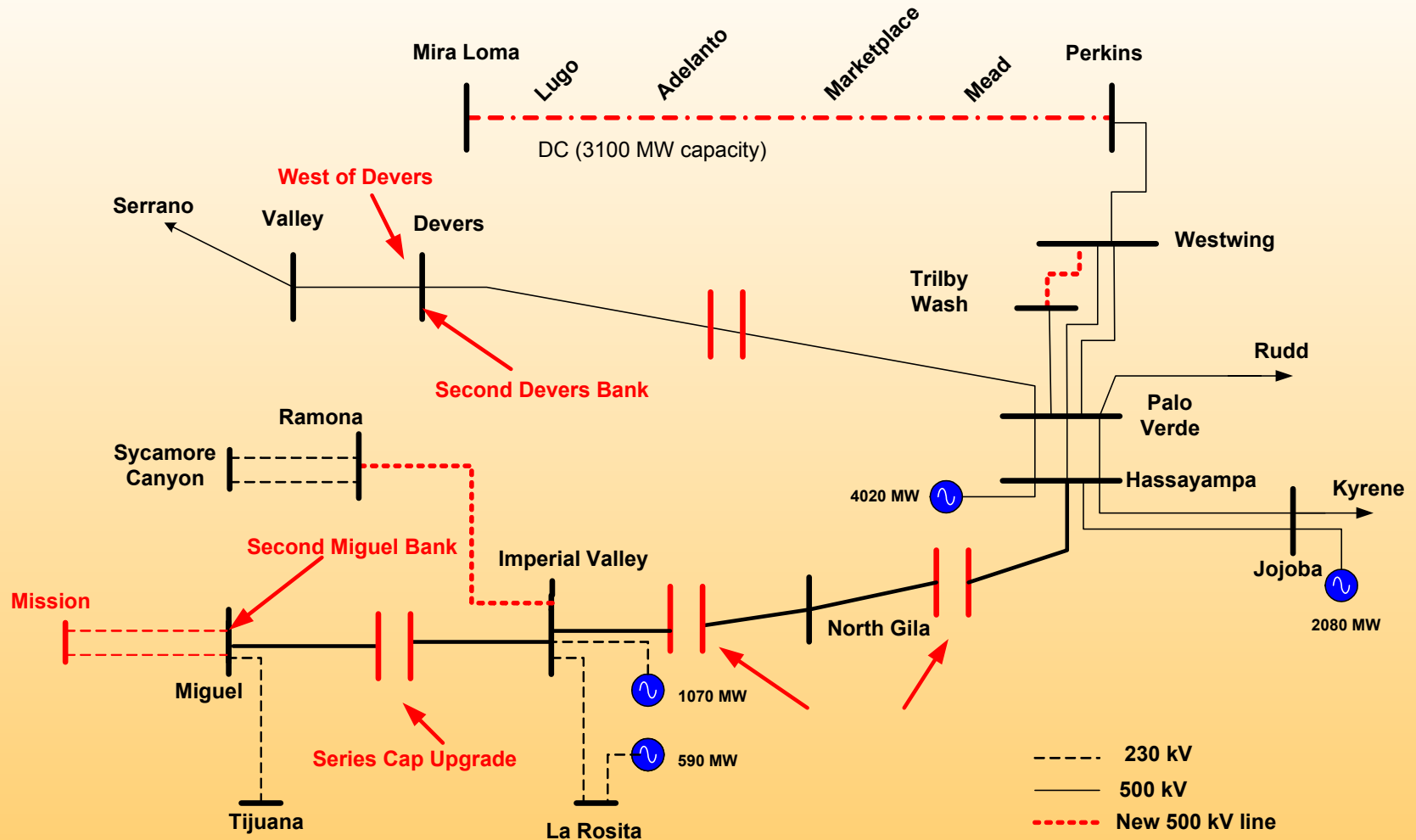


## Accumulative Benefits Due to Common Upgrades and AC 4



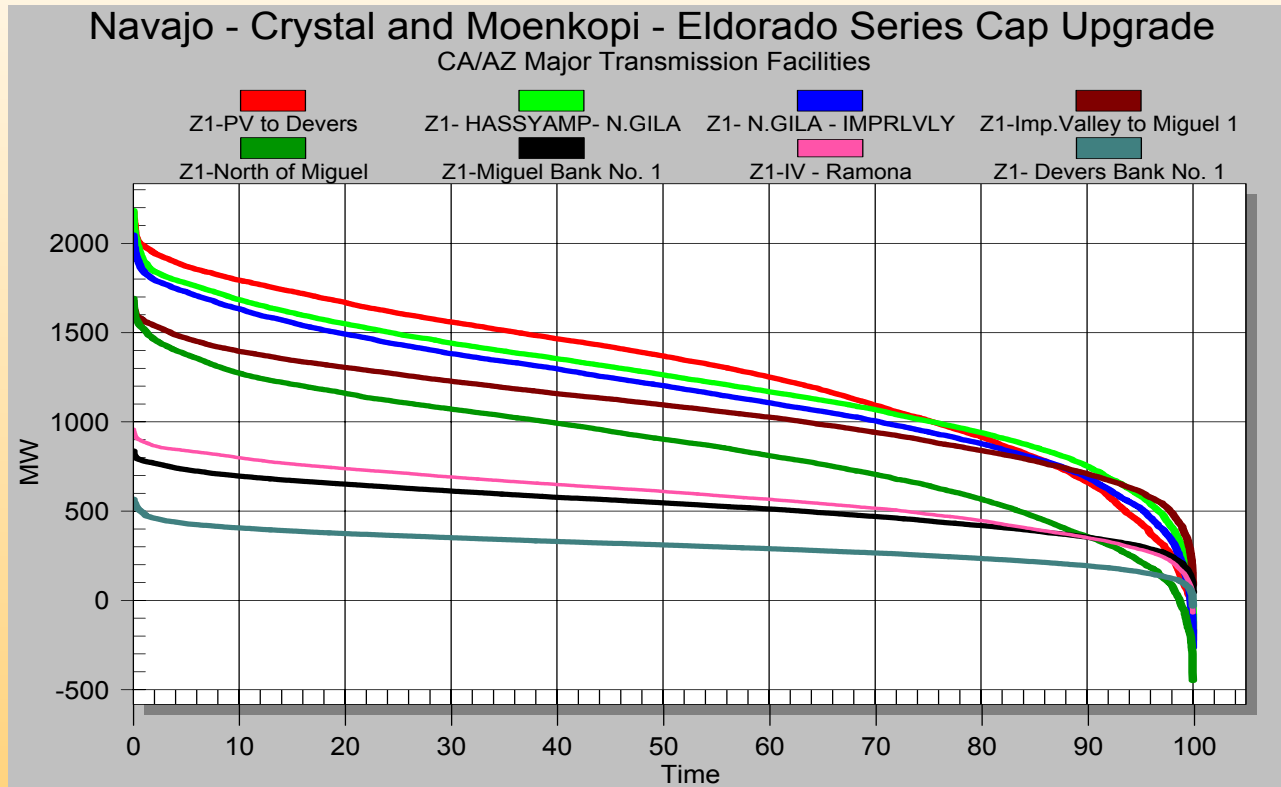


## Common Upgrades and DC 1



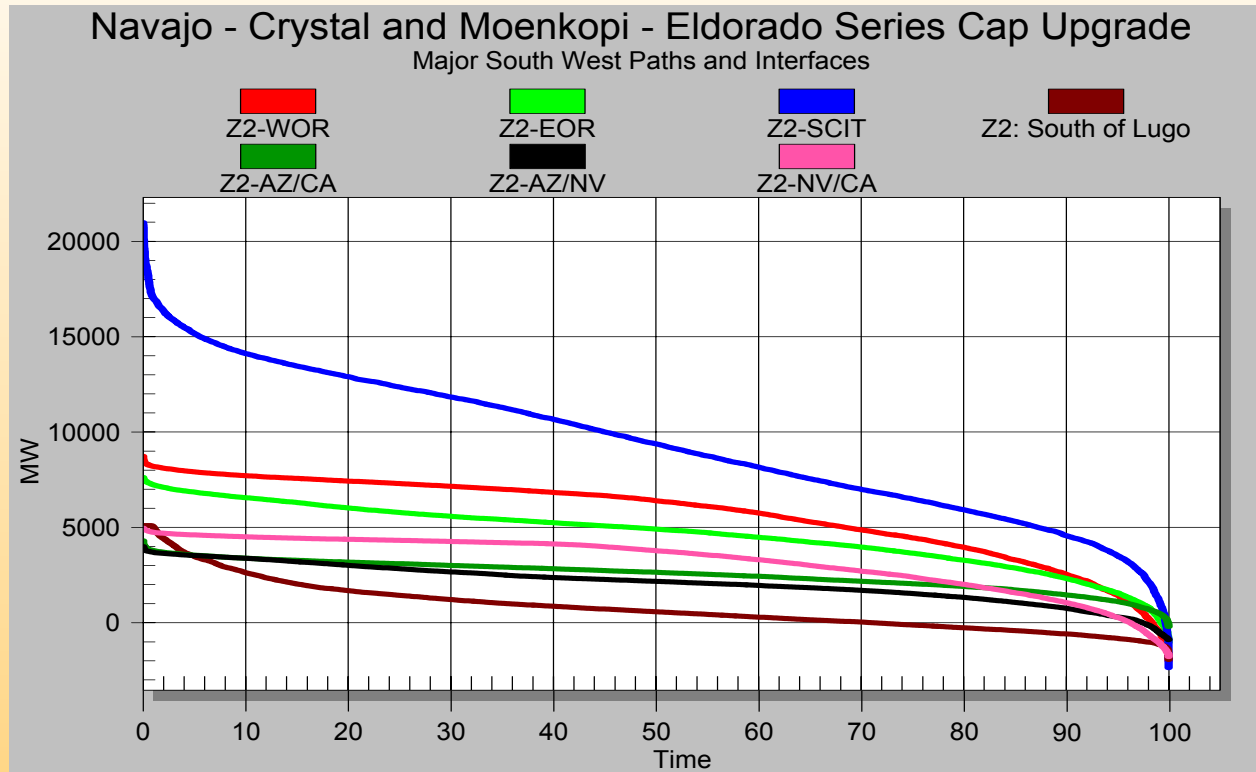


## Common Upgrades and DC 1



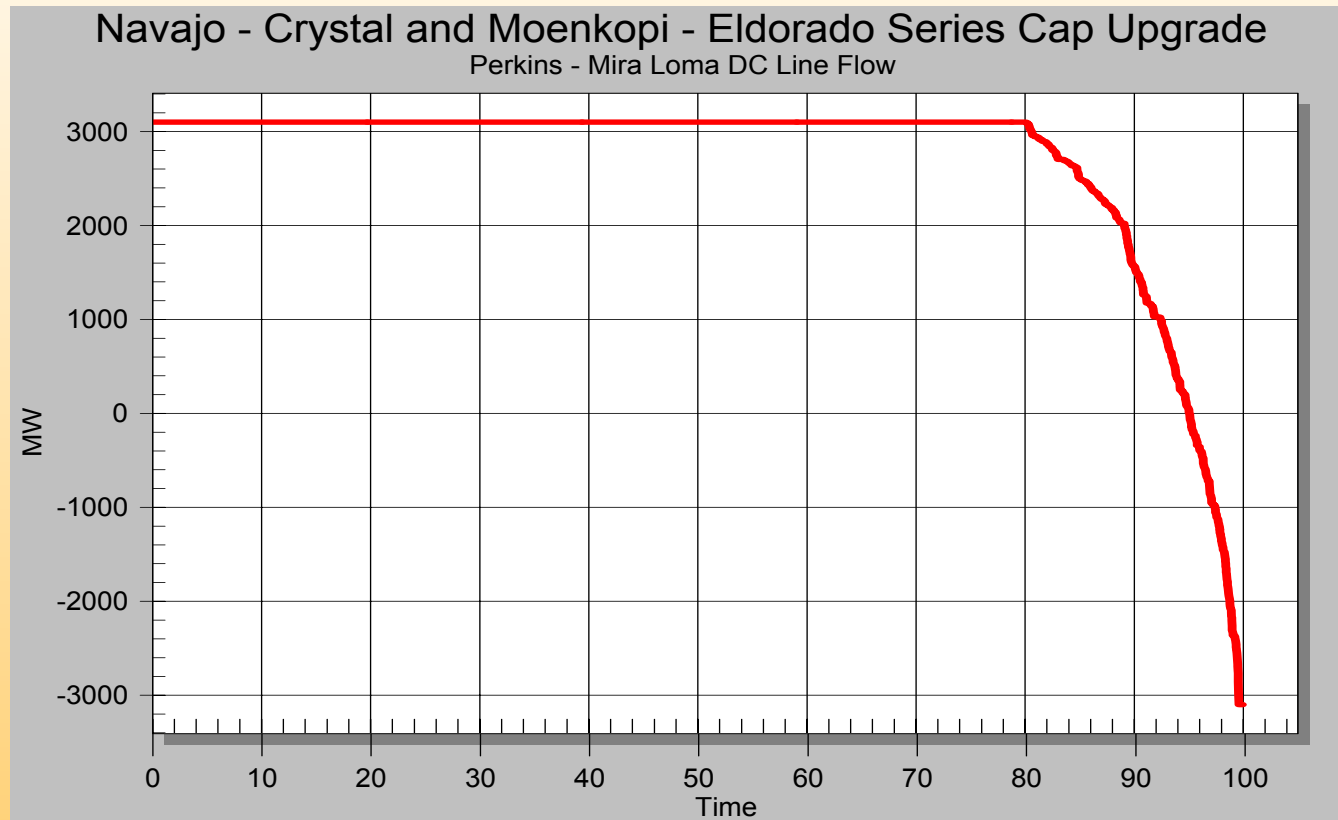


## Common Upgrades and DC 1





## Common Upgrades and DC 1

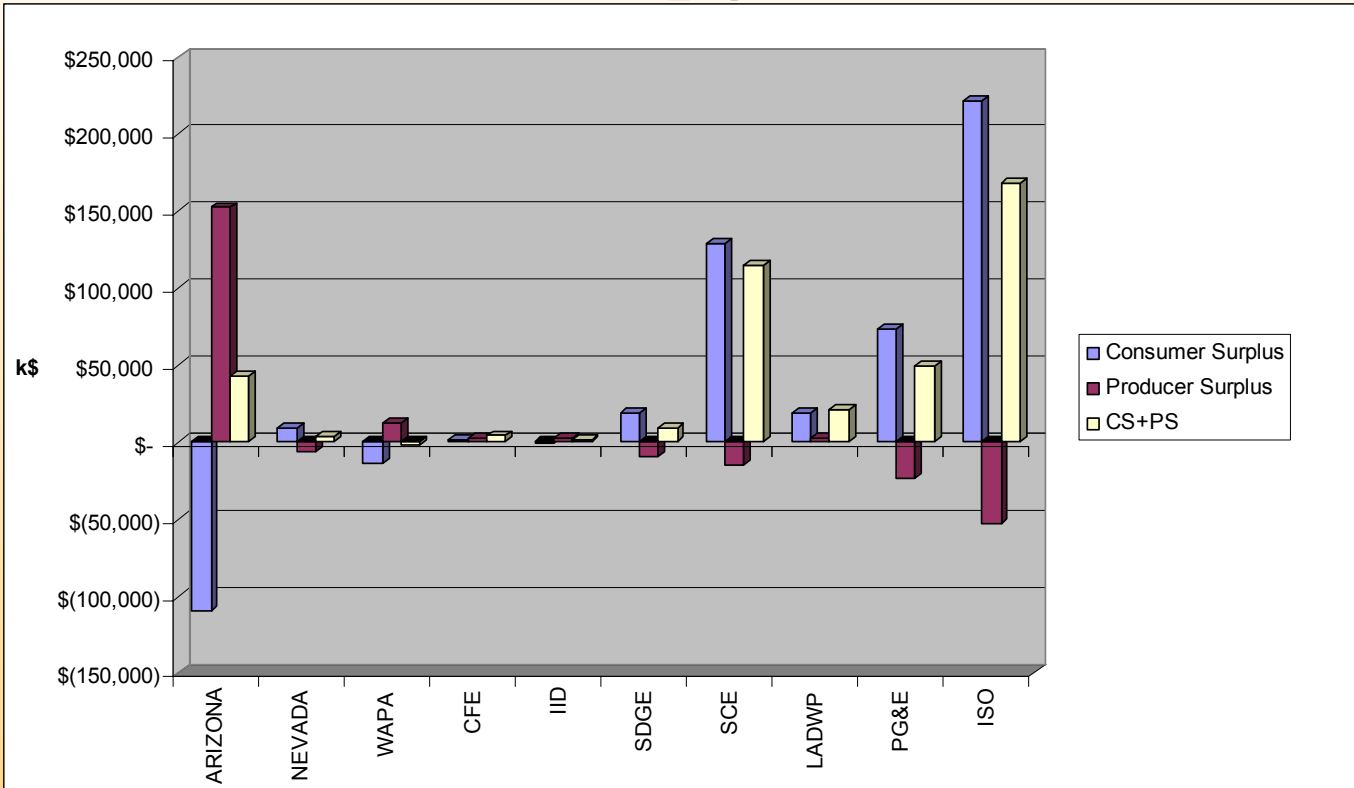




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## Accumulative Benefits Due to Common Upgrades and DC 1

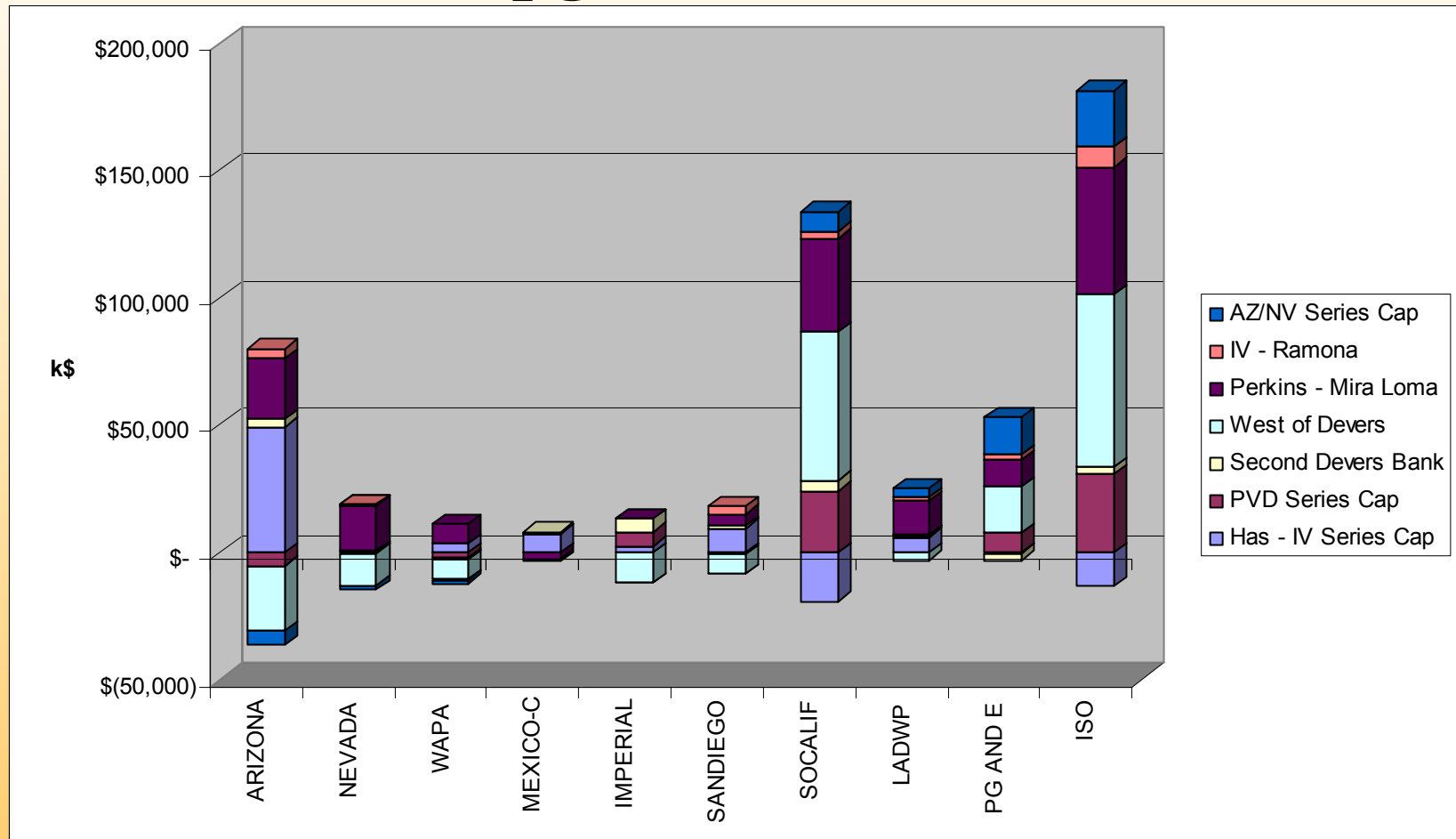


<b>Levelized Project Cost /Year</b>	
<b>\$</b>	<b>369,218.55</b>

	ARIZONA	NEVADA	WAPA	MEXICO-C	IMPERIAL	SANDIEGO	SOCALIF	LADWP	PG AND E	ISO
<b>CS</b>	-\$108,910.00	\$9,464.00	-\$13,677.00	\$1,949.00	-\$927.00	\$18,622.00	\$128,971.00	\$19,071.00	\$73,450.00	\$221,043.00
<b>PS</b>	\$152,283.48	-\$5,649.53	\$12,507.89	\$2,374.90	\$2,247.12	-\$9,212.30	-\$14,540.94	\$2,569.04	-\$23,709.93	-\$53,256.12
<b>CS+PS</b>	\$43,373.48	\$3,814.47	-\$1,169.11	\$4,323.90	\$1,320.12	\$9,409.70	\$114,430.06	\$21,640.04	\$49,740.07	\$167,786.88

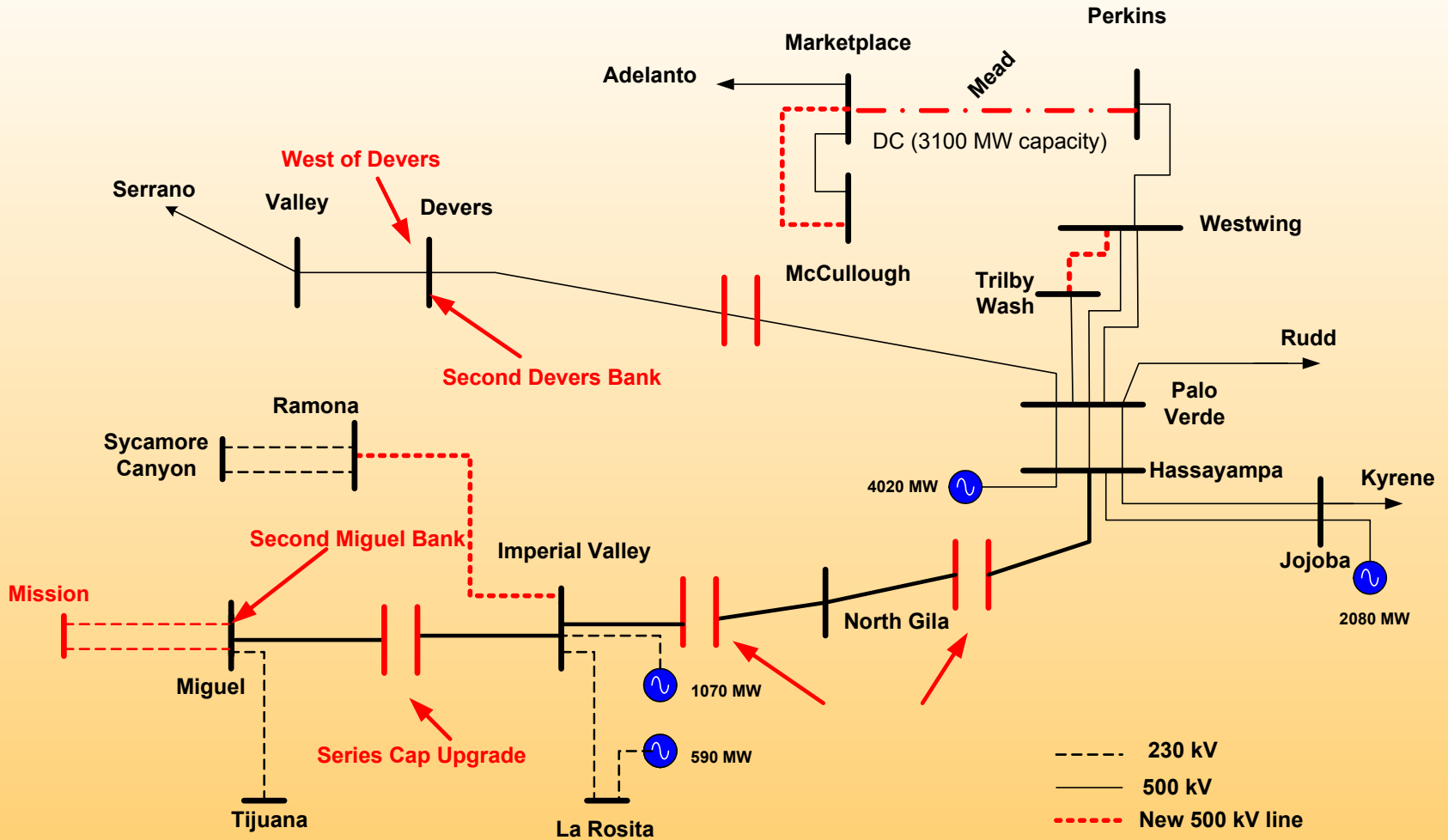


## Accumulative Benefits Due to Common Upgrades and DC 1



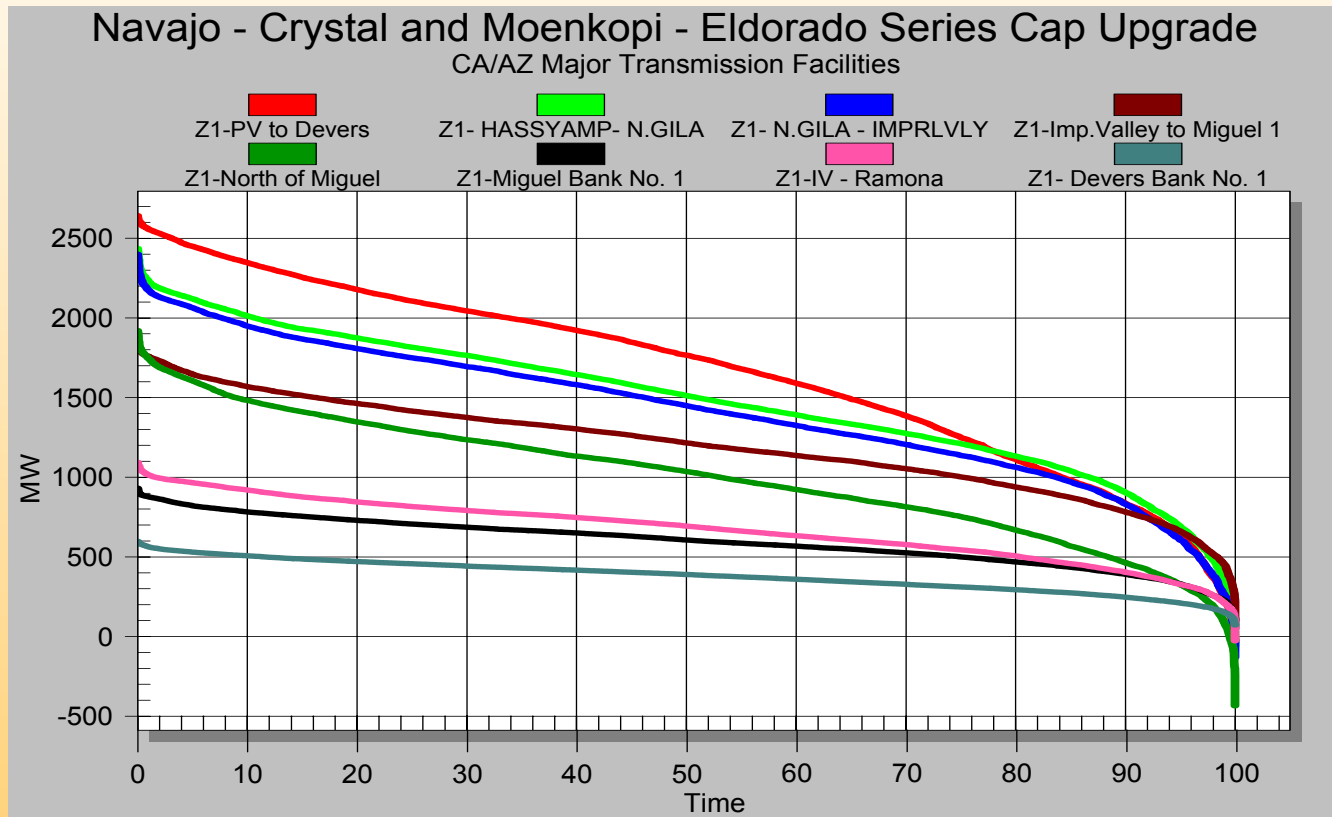


## Common Upgrades and DC 2



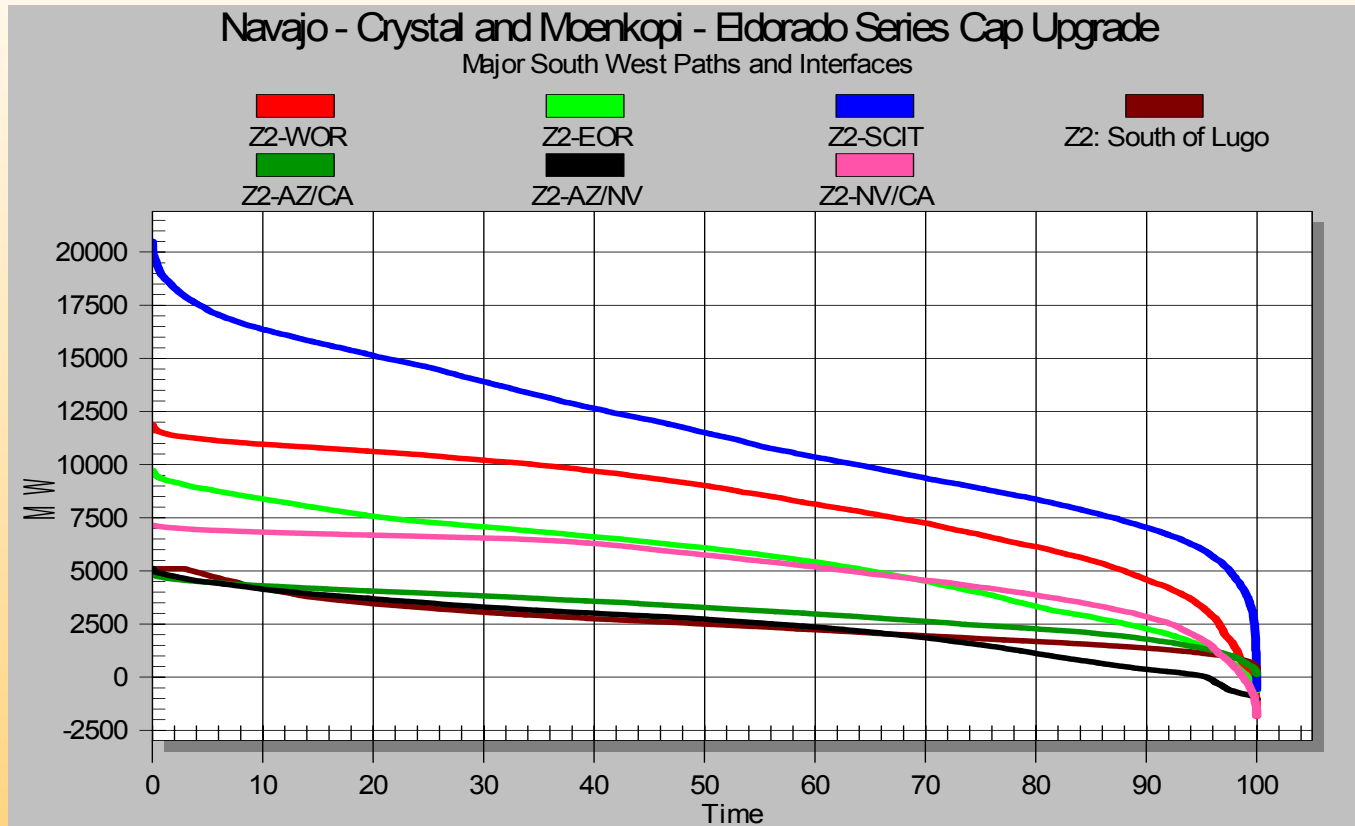


## Common Upgrades and DC 2



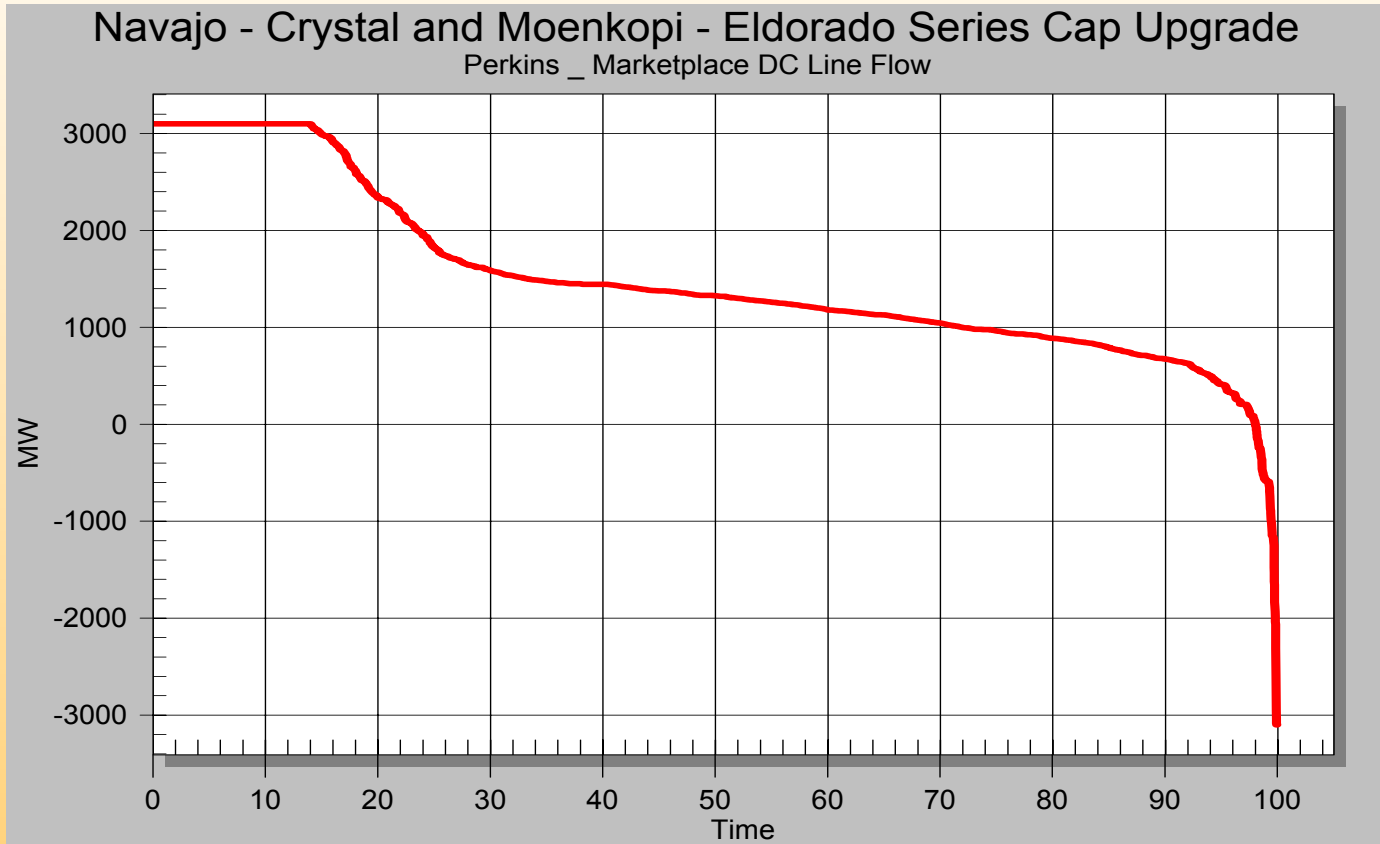


## Common Upgrades and DC 2





## Common Upgrades and DC 2

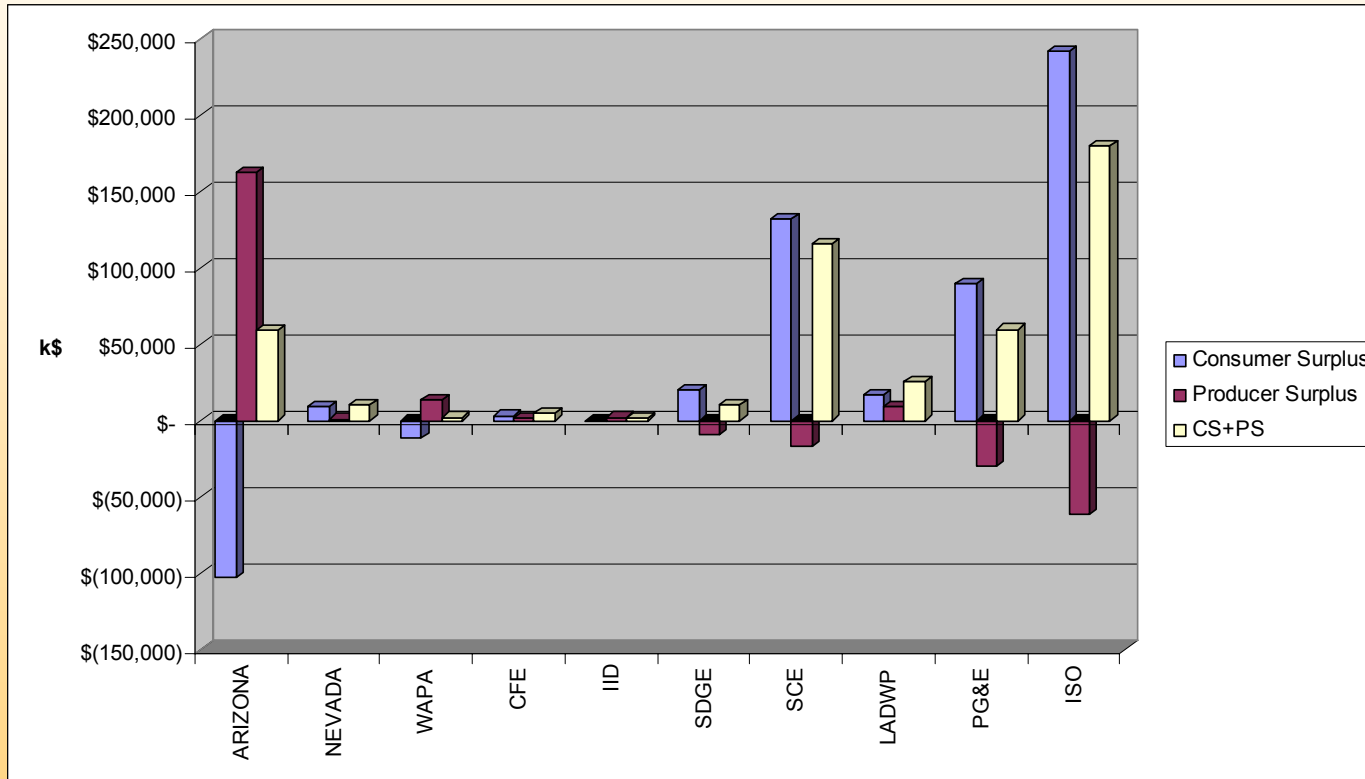




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## Accumulative Benefits Due to Common Upgrades and DC 2

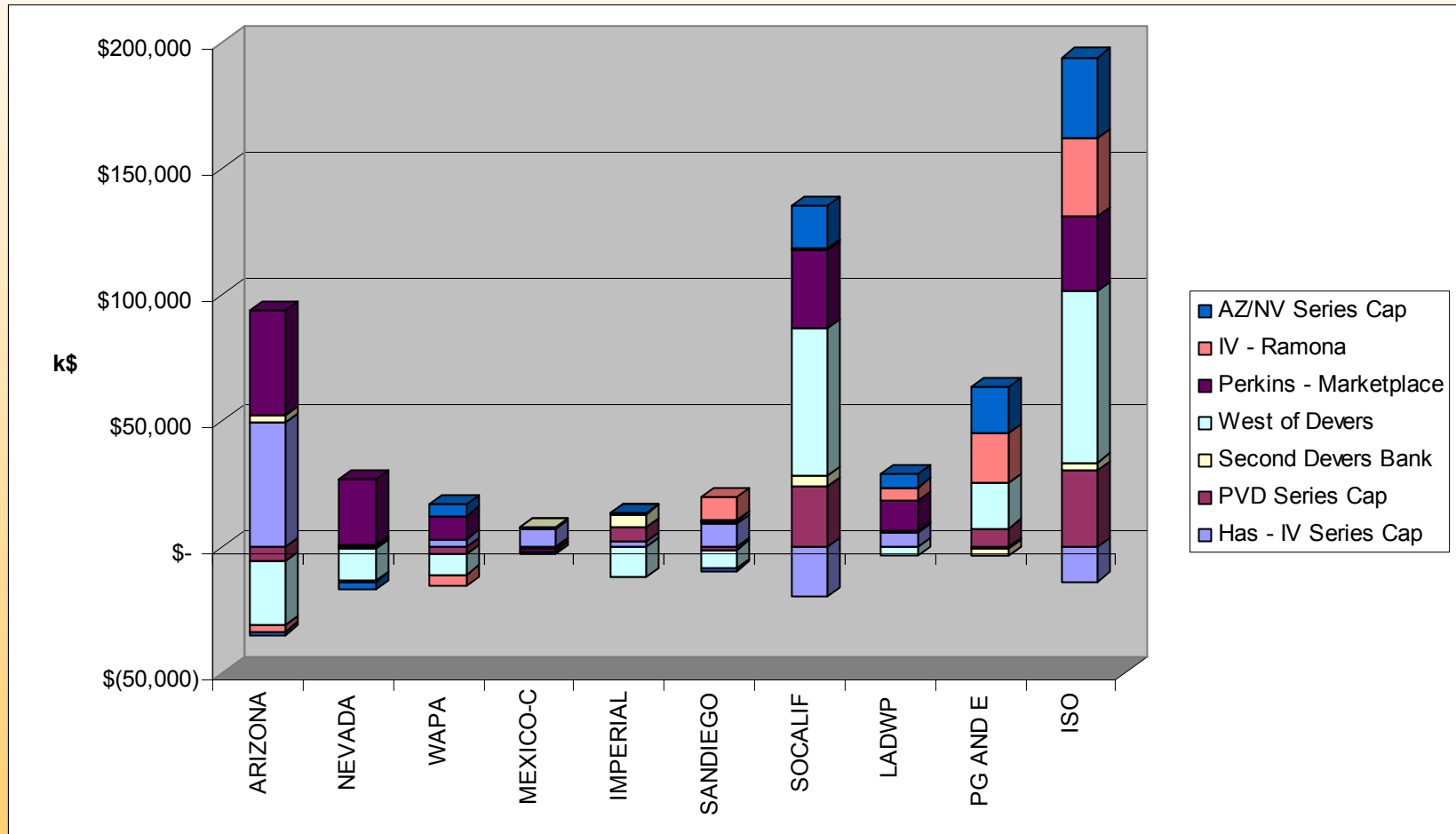


<b>Levelized Project Cost /Year</b>	<b>\$ 365,825.74</b>
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	ARIZONA	NEVADA	WAPA	MEXICO-C	IMPERIAL	SANDIEGO	SOCALIF	LADWP	PG AND E	ISO
<b>CS</b>	-\$102,879.00	\$9,085.00	-\$11,239.00	\$3,264.00	-\$599.00	\$20,221.00	\$132,328.00	\$16,761.00	\$89,419.00	\$241,968.00
<b>PS</b>	\$162,103.16	\$1,143.91	\$13,444.13	\$1,858.20	\$2,185.87	-\$9,583.10	-\$16,431.66	\$8,870.07	-\$29,638.66	-\$61,790.58
<b>CS+PS</b>	\$59,224.16	\$10,228.91	\$2,205.13	\$5,122.20	\$1,586.87	\$10,637.90	\$115,896.34	\$25,631.07	\$59,780.34	\$180,177.42

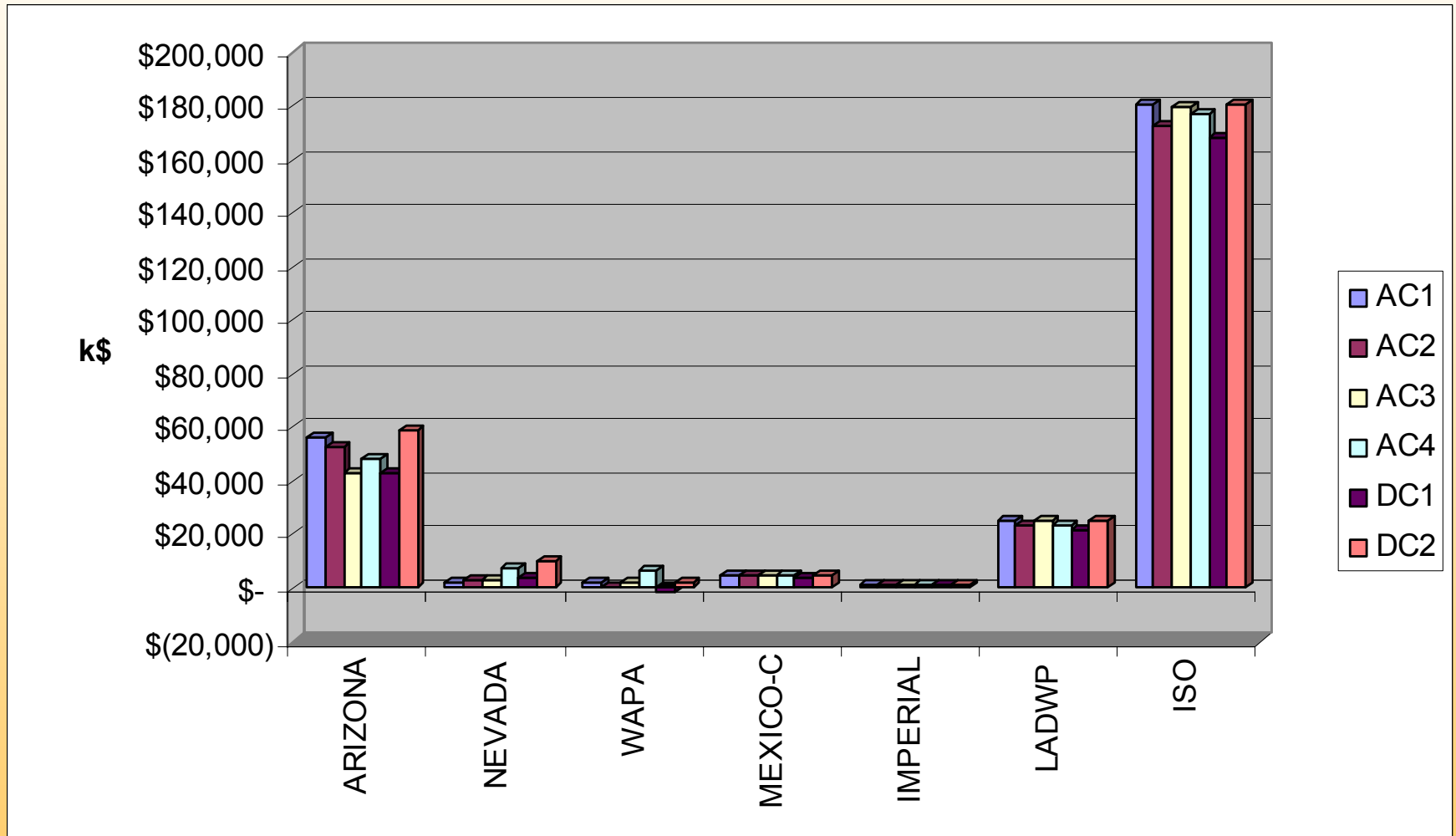


## Accumulative Benefits Due to Common Upgrades and DC 2





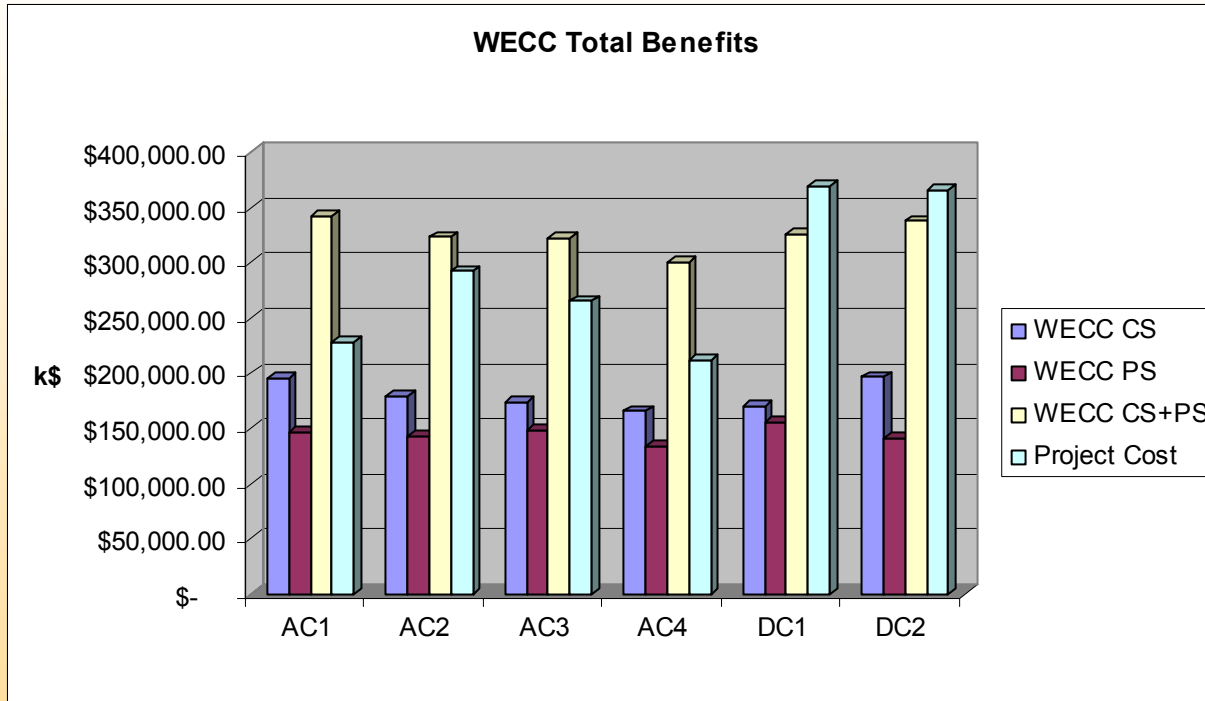
## Comparing Alternatives (Total Benefits)





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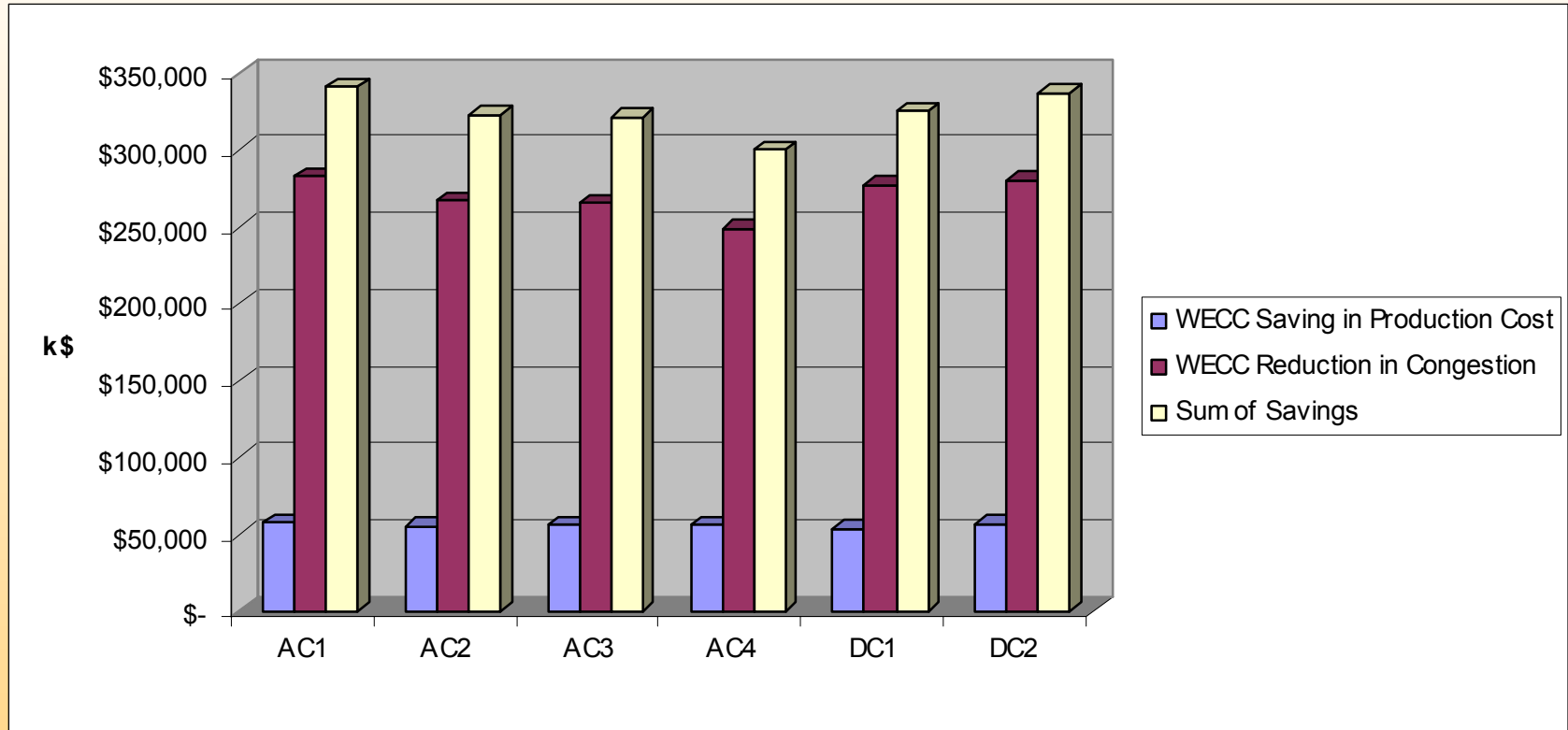
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	AC1	AC2	AC3	AC4	DC1	DC2
WECC CS	\$ 194,970	\$ 179,897	\$ 173,214	\$ 165,772	\$ 169,730	\$ 196,540
WECC PS	\$ 146,345	\$ 143,235	\$ 148,389	\$ 134,339	\$ 155,806	\$ 140,831
Project Cost	\$ 227,319	\$ 292,182	\$ 265,239	\$ 212,351	\$ 369,219	\$ 365,826



## WECC Total Benefits



	AC1	AC2	AC3	AC4	DC1	DC2
Reduction in Production Cost	\$ 57,998	\$ 55,574	\$ 55,878	\$ 56,570	\$ 53,823	\$ 56,615
Reduction in Congestion Rent	\$ 283,306	\$ 267,591	\$ 265,721	\$ 249,208	\$ 277,521	\$ 280,791