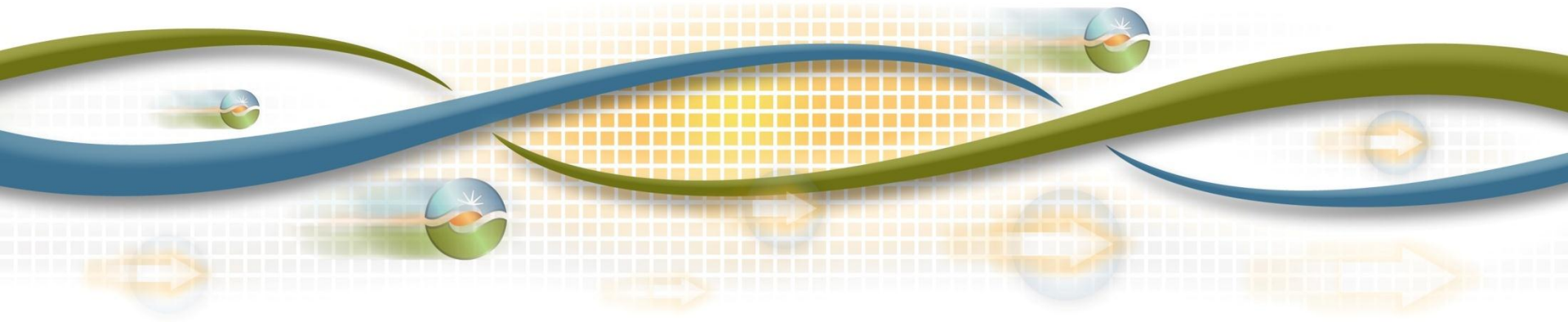


Economic Planning Studies – Final Results

Draft 2012/2013 ISO Transmission Plan Stakeholder Meeting

Xiaobo Wang, PhD
Regional Transmission Engineering Lead
February 11, 2013



Overview of the economic planning study

ISO Transmission Plan 2012-2013

This year's high priority studies covered five congestion areas

- ❖ Eleven alternatives were analyzed in the study, where economic benefits of proposed network upgrades were assessed for the ISO ratepayers
- ❖ Two alternatives were found to have significant economic benefits
- ❖ Comprehensive sensitivity analyses were made to test the robustness of the economic benefits under planning uncertainties

For the two new transmission lines with significant economic benefits:

- ❖ The study recommends project approval for the proposed *Delany – Colorado River 500 kV line* as an economically-driven network upgrade
- ❖ The study recommends further analysis for the proposed *Harry Allen – Eldorado 500 kV line*

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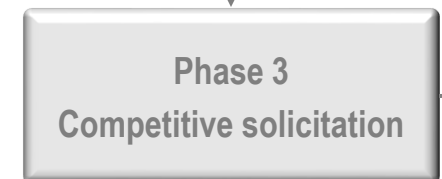
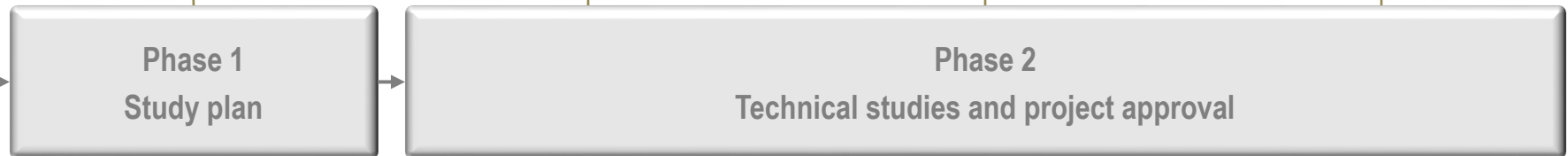
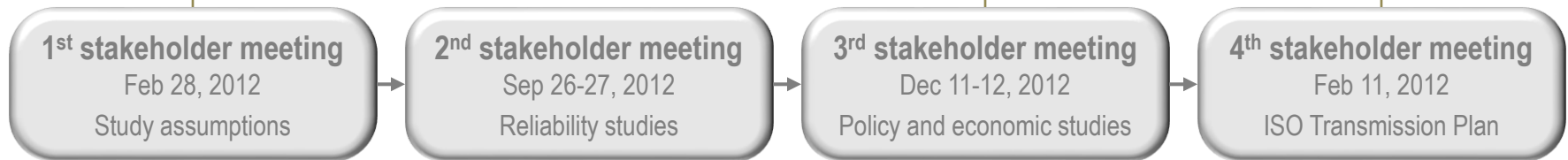
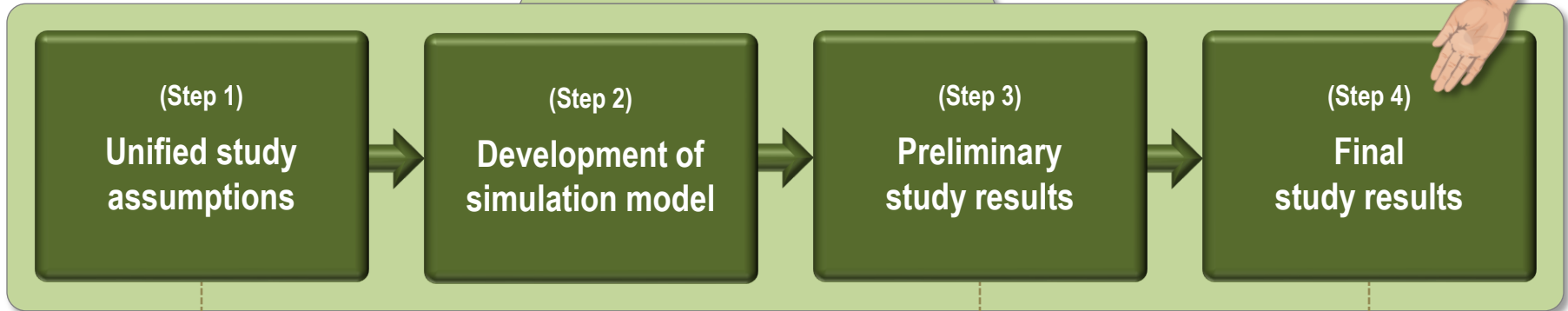
Summary

Steps of economic planning studies

ISO Transmission Plan 2012-2013

We are here

Economic planning studies



CAISO transmission planning process (TPP)

Methodology and study assumptions

ISO Transmission Plan 2012-2013: Economic planning study

Please see the prior presentation:

“Economic Planning Studies – Preliminary Results”

2012/2013 Transmission Planning Process Stakeholder Meeting, Dec 11-12, 2012



Process, methodology and study assumptions

System overview

Economic planning studies (preliminary results)

Summary

From the last planning cycle to this one

What have significantly changed? Why are benefits higher or lower?

Major study assumption changes and modeling advancements

	<div>2011-2012 Transmission Plan CAISO “DB120120”</div>	<div>2012-2013 Transmission Plan CAISO “DB130201”</div>
Study assumptions	CPUC RPS 33%: Cost-Constrained (CC) portfolio	CPUC RPS 33%: Commercial Interest (CI) portfolio
	California: CEC demand forecast of Dec-2009	California: CEC demand forecast of Sep-2012
	Out-of-state: WECC LRS demand forecast 2010	Out-of-state: WECC LRS demand forecast 2012
Reference DB	TEPPC “2020 PC0” dataset released on 22-Nov-2010	TEPPC “2022 PC1” dataset released on 02-May-2012
ISO modeling additions and enhancements	Added missing network upgrades	Added missing network upgrades newly-approved
	Summer ratings for transmission elements	Summer and winter ratings for transmission elements
	N/A	Control area modeling
	N/A	Flexible reserve modeling
	WECC-wide emission model	California-only AB32 emission model
	Demand side management model	Rectified demand side management model

Identified congestion and high priority studies

Simulated congestion

#	Area	Congested transmission element	Congestion duration (hours)		Average congestion cost (\$M)
			Year 2017	Year 2022	
1	PG&E - SCE	Path 26 (Midway – Vincent) ① ⑤	1534	832	16.488
2	PG&E - TID	Los Banos North (LBN) ②	-	167	1.999
3	SCE - LADWP	Path 61 (Victorville – Lugo) ⑤	-	308	0.878
4	PG&E	Central California Area (CCA) ③	1	106	0.431
5	SCE	Kramer area +	45	7	0.339
6	SCE	Inyo area	88	902	0.195
7	SCE	Mirage – Devers area ⑤	52	17	0.164
8	PG&E	Greater Bay Area (GBA)	15	16	0.032
9	SCE	Big Creek area	-	2	0.009
10	SDG&E	San Diego area	-	9	0.009
11	PG&E - PacifiCorp	Path 25 (PacifiCorp/PG&E 115 kV Interconnection) ④	-	40	0.004
12	PG&E - NVE	Path 24 (PG&E – Sierra)	-	17	0.002

High priority studies

	Study ID	Study subject
①	P26	Path 26 Northern - Southern CA
②	LBN	Los Banos North
③	CCA	Central California Area
④	NWC	Pacific Northwest - California
⑤	SWC	Desert Southwest - California

Ranked by severity ▲

+ AV Clearview study

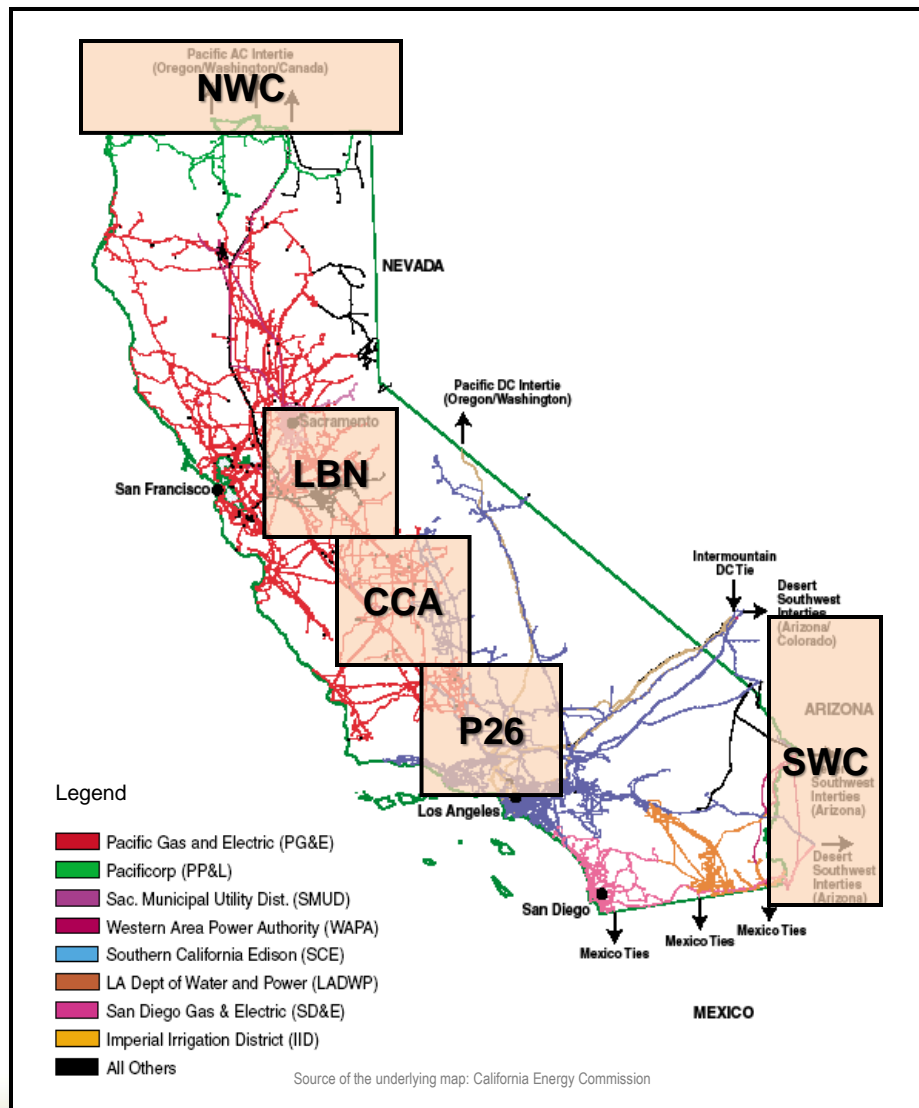
A special study on renewable transmission
See other presentation:

"Alternatives considered to the
Coolwater-Lugo Project: AV
Clearview Transmission Project"

Economic
planning
studies

TP2012-2013: Economic planning study

Geographic locations of the five high priority studies



Study ID	Study subject
P26	Path 26 Northern - Southern CA
LBN	Los Banos North
CCA	Central California Area
NWC	Pacific Northwest - California
SWC	Desert Southwest - California

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Summary

Path 26 area



Study of Path 26

Congestion on Path 26 Midway – Vincent 500 kV lines #1 and #2

Limiting constraints:

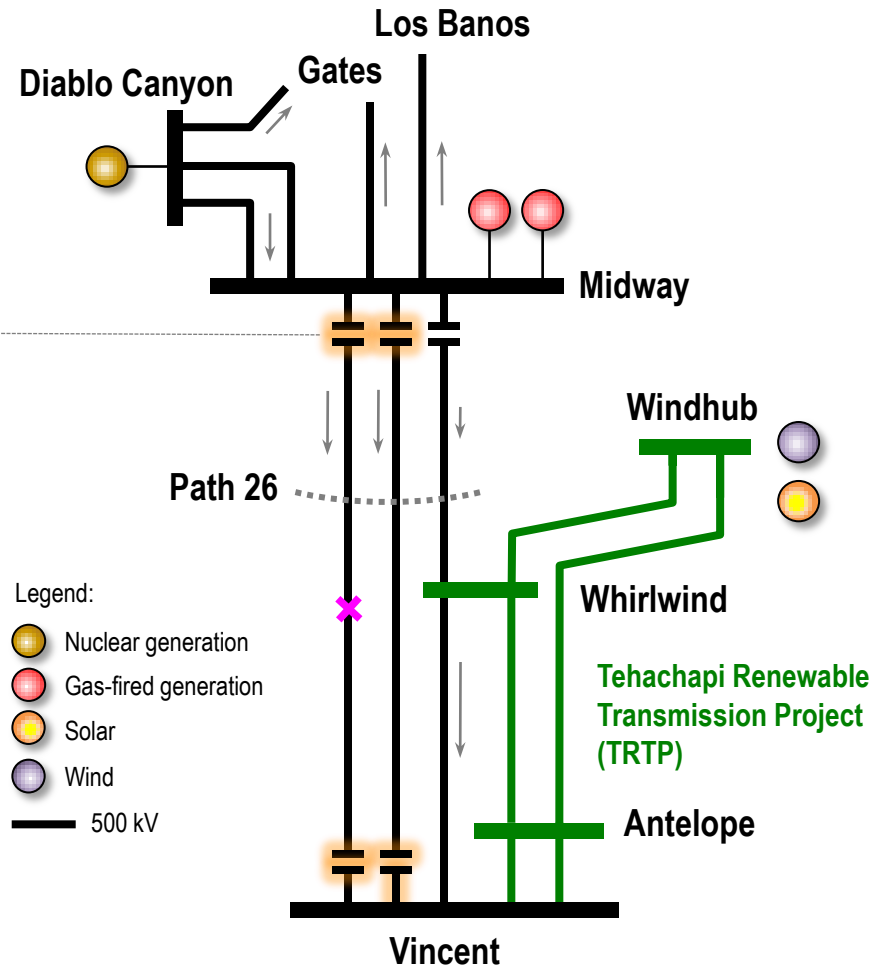
Midway – Vincent 500 kV #1 and #2 lines
subject to L-1 on Path 26

Congestion hours

2017	2022
1534	832

Limiting elements:

Series capacitors on the two lines



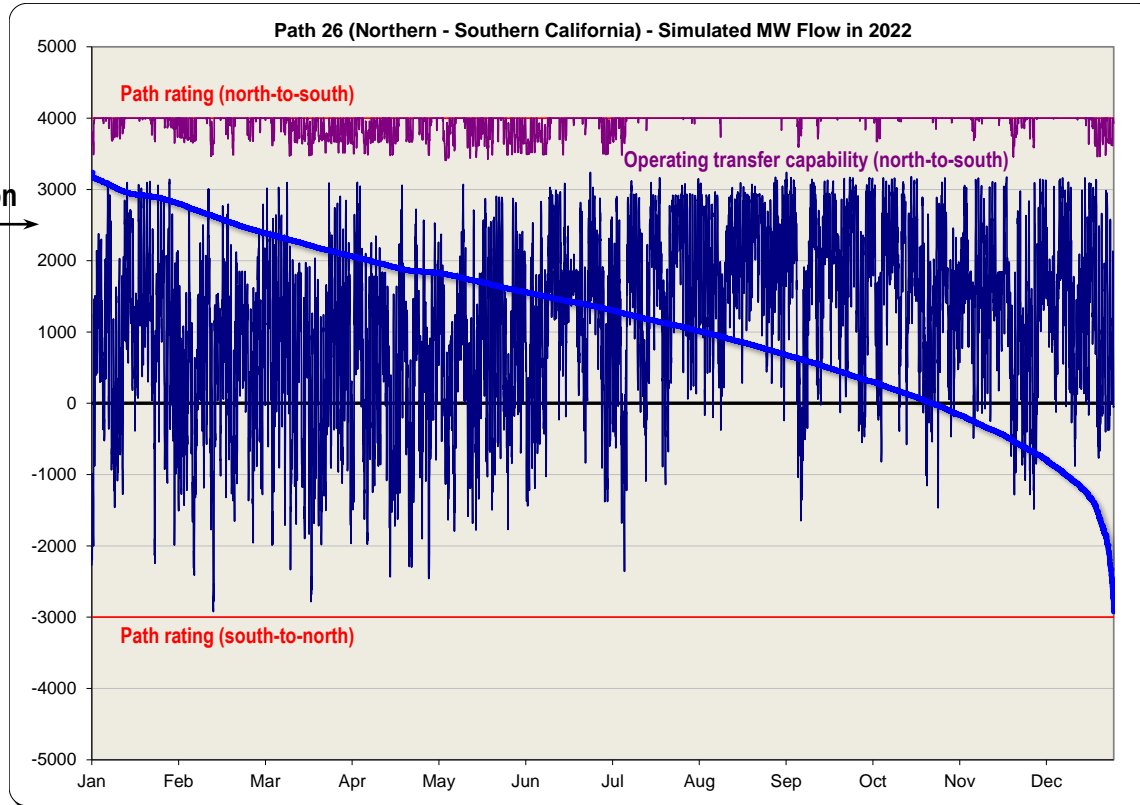
Implications of the L-1 constraints:

Path 26 operational limit can often be lower than the 4000 MW rating

See the simulation results in the next slide

Simulated power flow on Path 26 and individual lines

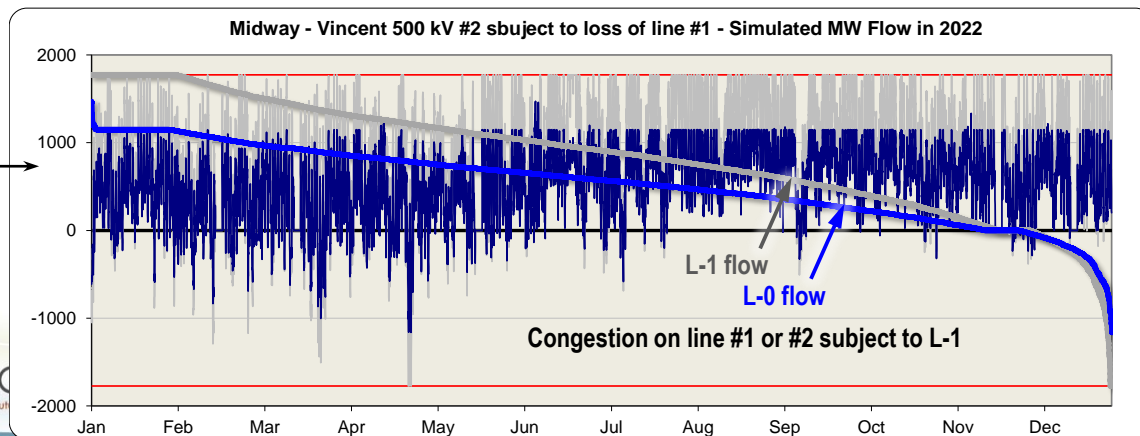
Path 26 path flow
under normal condition



Observation 1:
Before path rating and operating transfer limits are reached, #1 and #2 line are already congested

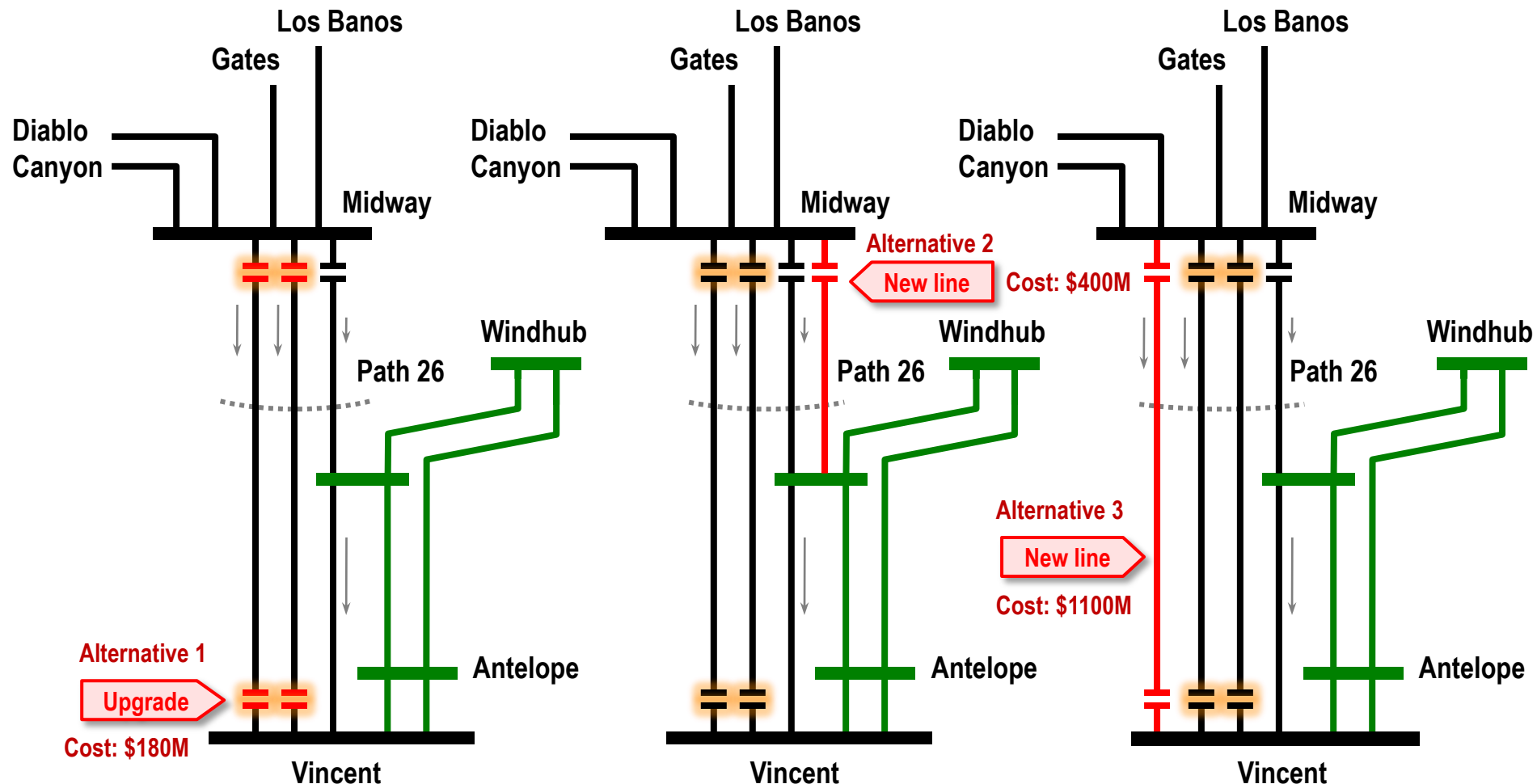
Observation 2:
The congestion is predominantly from north to south, but can also be in the opposite direction

Midway – Vincent
500 kV Line #2 flow



Economic assessment of Path 26 upgrades

Three alternatives analyzed



Simulation results and observations:

All alternatives have small dollar benefits due to canceled north-south benefits and reduced congestion revenue

As a result, none of the alternatives delivers a positive net benefit

Conclusions and recommendations

Economic planning study for Path 26

Assessment:

Alt	Description	Year	Capital cost	Total cost	Total benefit
1	Upgrade series caps on Midway – Vincent 500 kV lines #1 & #2	2017	\$180M	\$261M	~0
2	Build Midway – Whirlwind 500 kV line #2 (80 miles)	2017	\$400M	\$580M	~0
3	Build Midway – Vincent 500 kV #4 (110 miles)	2017	\$1,100M	\$1,595M	~0

Conclusion:

Insufficient economic justifications for the proposed network upgrades

Comments:

Path 26 congestion has been top-ranked in the ISO studies for four consecutive years
The congestion is not only a forecasted condition but also an operations reality
However, studies have not found significant economic benefit to relieve this congestion
The reason is that north and south LMP changes result in canceled dollar benefits

Recommendation:

The Path 26 congestion will be investigated further for justifications of congestion relief
In absence of justifications, Path 26 congestion will be managed by dispatch in market operations

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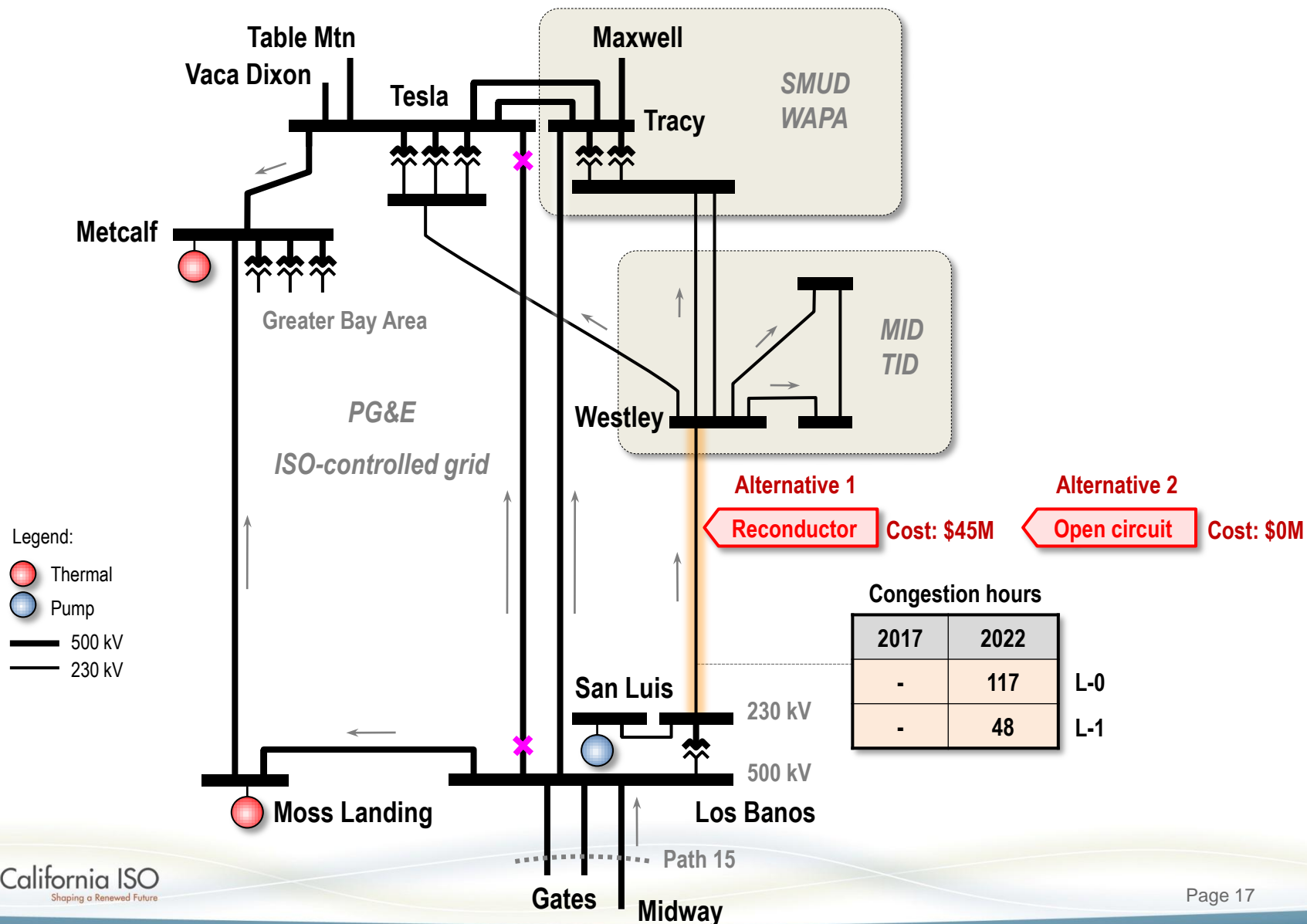
Summary

Los Banos North (LBN) area

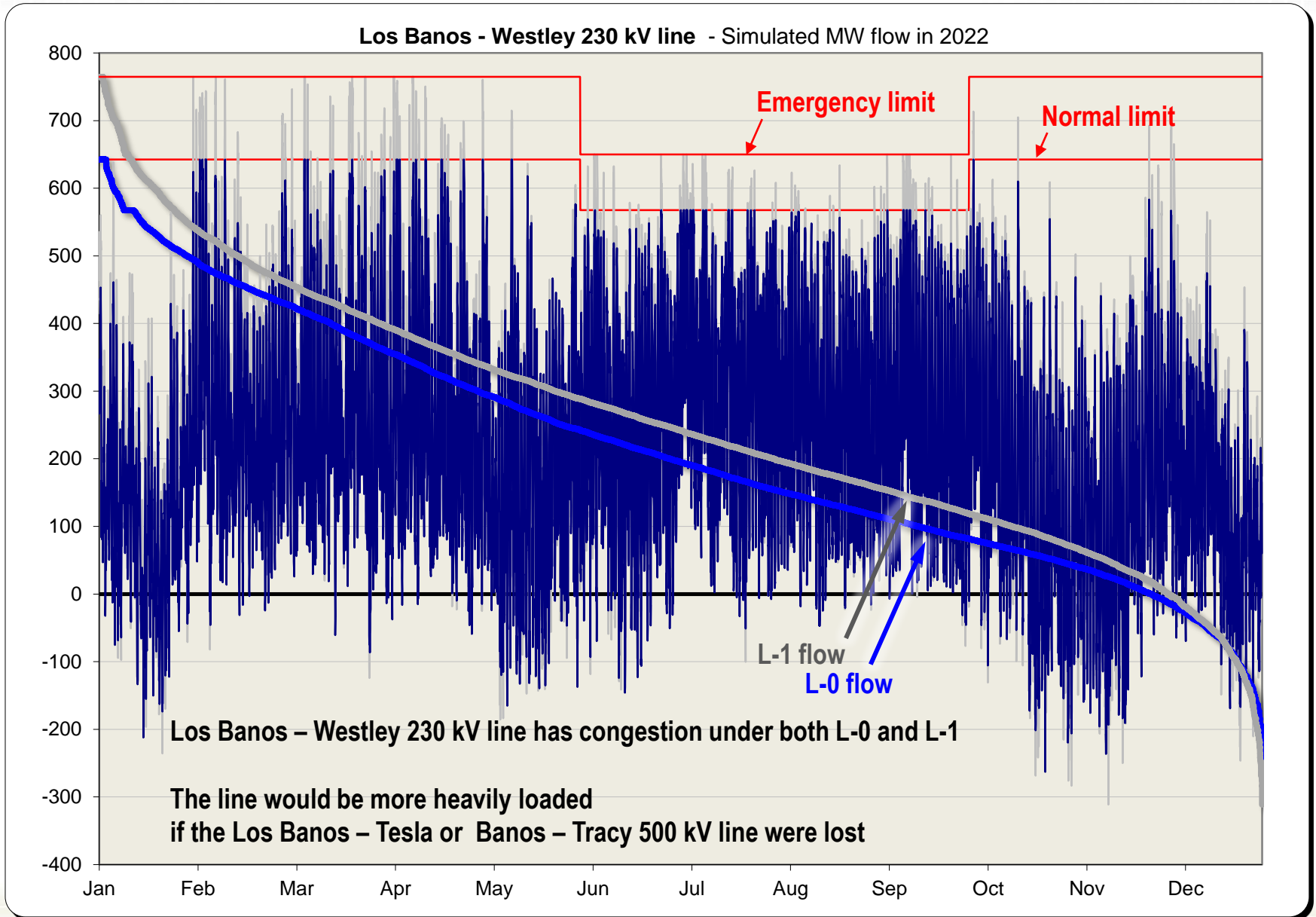


Study of the Los Banos North (LBN) area

Two alternatives studied



Simulated power flow on the Los Banos – Westley line



Conclusions and recommendations

Economic planning study for Los Banos North (LBN)

Economic assessment

Alt	Description	Year	Capital cost	Total cost	Total benefit
1	Re-conductor Los Banos – Westley 230 kV line (35 miles)	2022	\$45M	\$65M	~0
2	Open circuit for the Los Banos – Westley 230 kV line	2022	\$0M	\$0M	~0

Conclusion

Insufficient economic justifications for the proposed upgrade or configuration change

Comments

The Los Banos – Westley bottleneck is a recurring congestion in the ISO planning studies. However, there has not been economic justification for the studied network upgrades.

Recommendation

In absence of economic justifications, will rely on congestion management in the market.

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Study 4: Pacific Northwest - California (NWC)

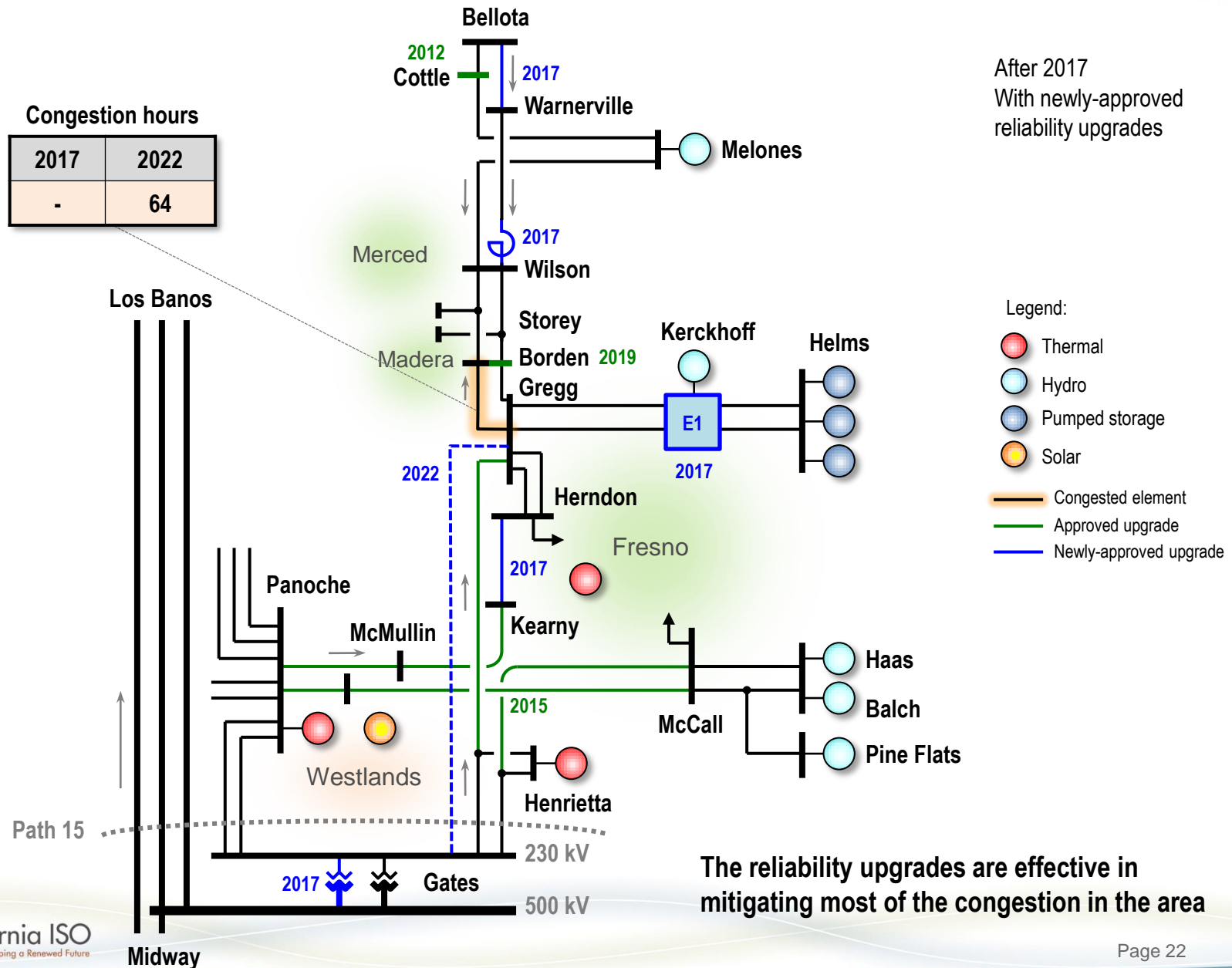
Study 5: Desert Southwest - California (SWC)

Summary

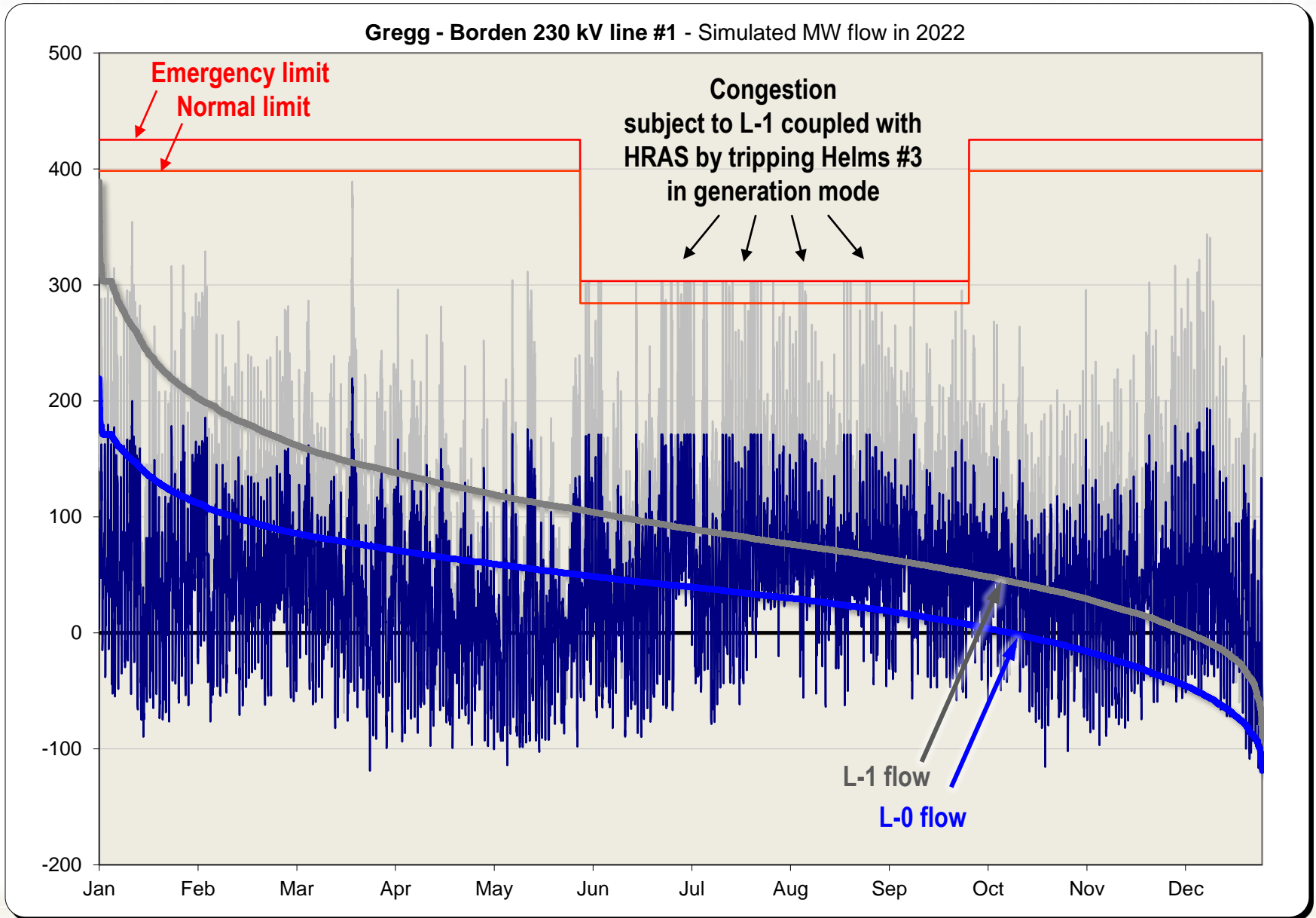
Central California Area (CCA)



Study of Central California Area (CCA)

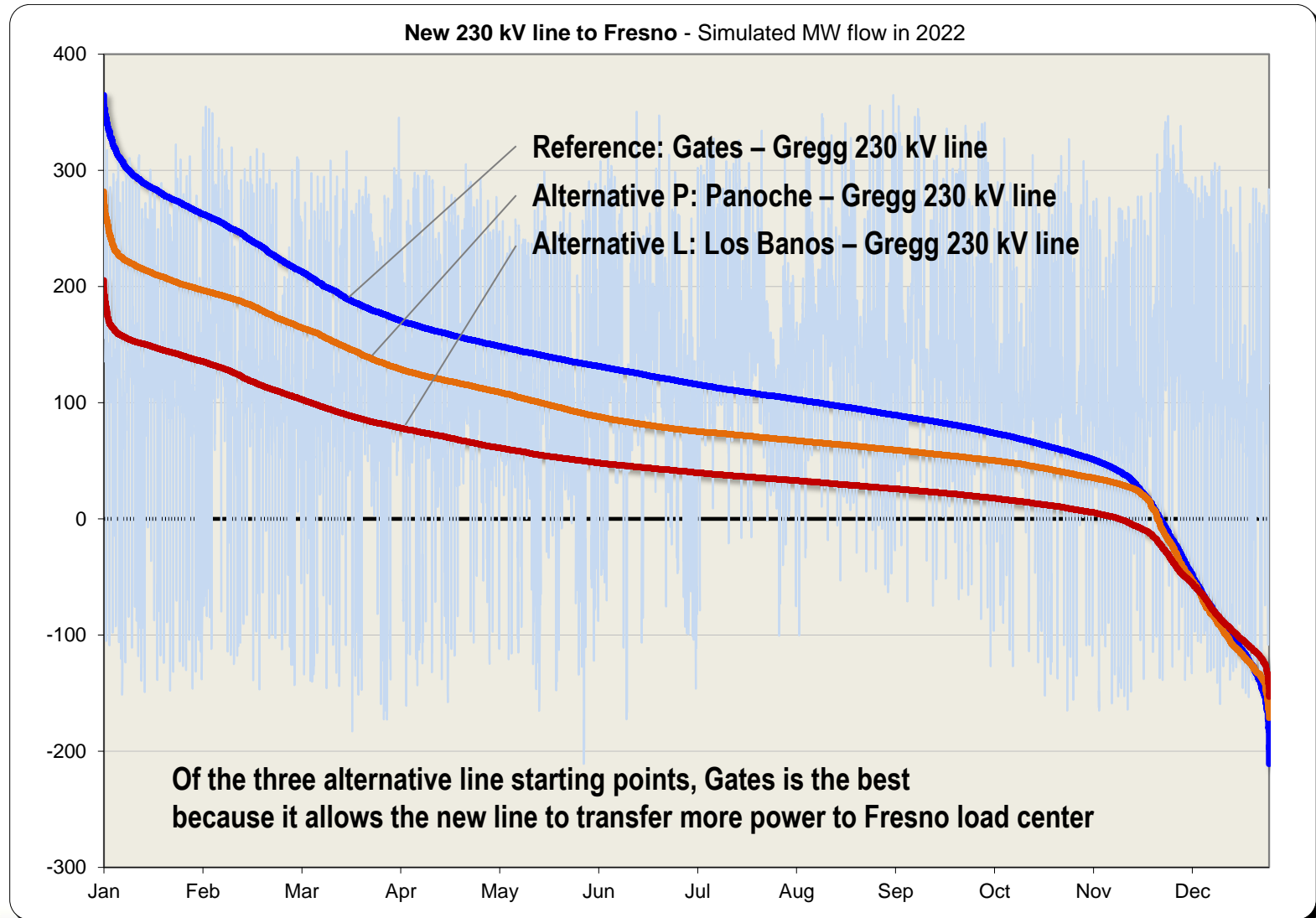


Simulated power flow on the Gregg – Borden 230 kV line



Gates – Gregg 230 kV line compared with alternatives

Simulated power flow on the new line



Conclusions and recommendations

Economic planning study for the Central California Area (CCA)

Assessment: Incremental costs and benefits in comparison with the reference, i.e. Gates – Gregg 230 kV line

Alt	Description	Year	Capital cost	Total cost	Total benefit
Δ(P-G)	Panoche – Gregg 230 kV line instead of Gates - Gregg	2022	\$0M	\$0M	(\$14M)
Δ(L-G)	Los Banos – Gregg 230 kV line instead of Gates - Gregg	2022	\$100M	\$145M	(\$115M)

Conclusion:

The Panoche – Gregg 230 kV line is economically inferior even if it costs the same

The Los Banos – Gregg 230 kV line is economically more inferior; and it also costs a lot more

Recommendation:

The Gates – Gregg 230 kV line is reaffirmed as a better configuration than starting the line from Panoche or Los Banos

Comments on Gregg – Borden 230 kV line congestion:

The Gregg – Borden congestion may limit Helms output when two or three units are generating

Shall consider expand the existing HRAS if feasible

Or better, reconductor the Gregg – Borden – Storey 230 kV lines (2 x 10 miles)

This technical matter can be investigated in future studies

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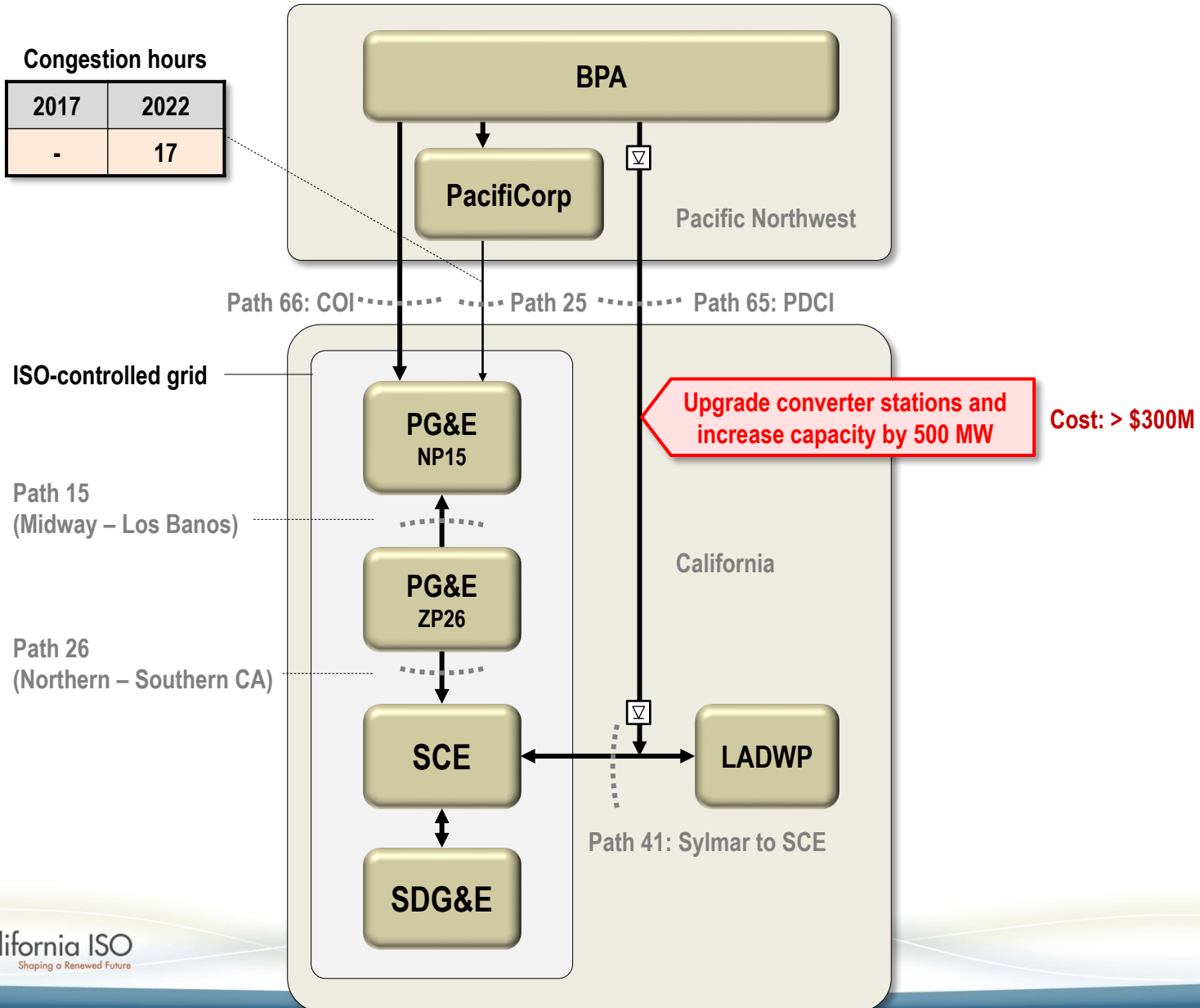
Study 4: Pacific Northwest - California (NWC)

Study 5: Desert Southwest - California (SWC)

Summary

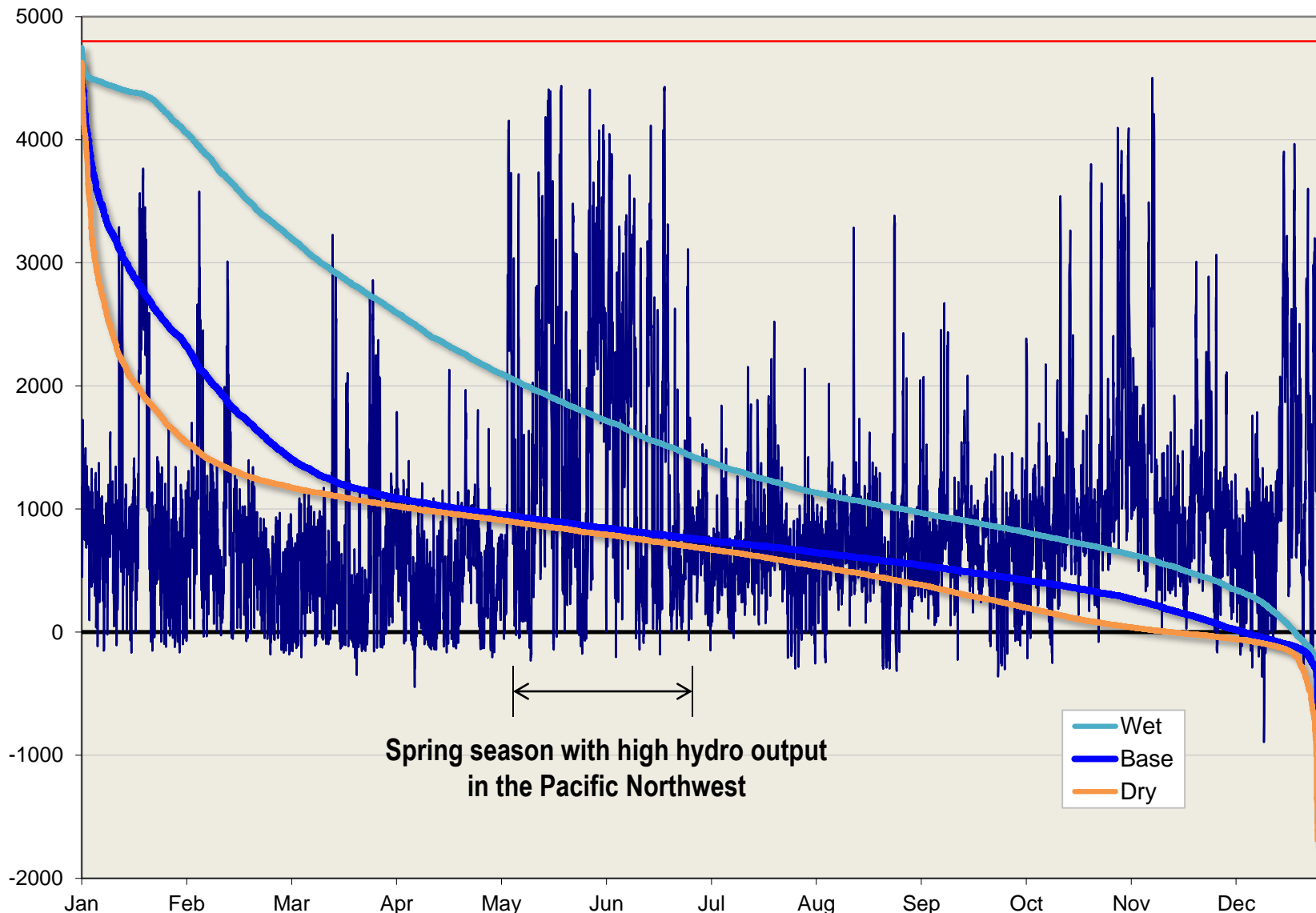
Pacific Northwest – California (NWC) area

One alternative studied

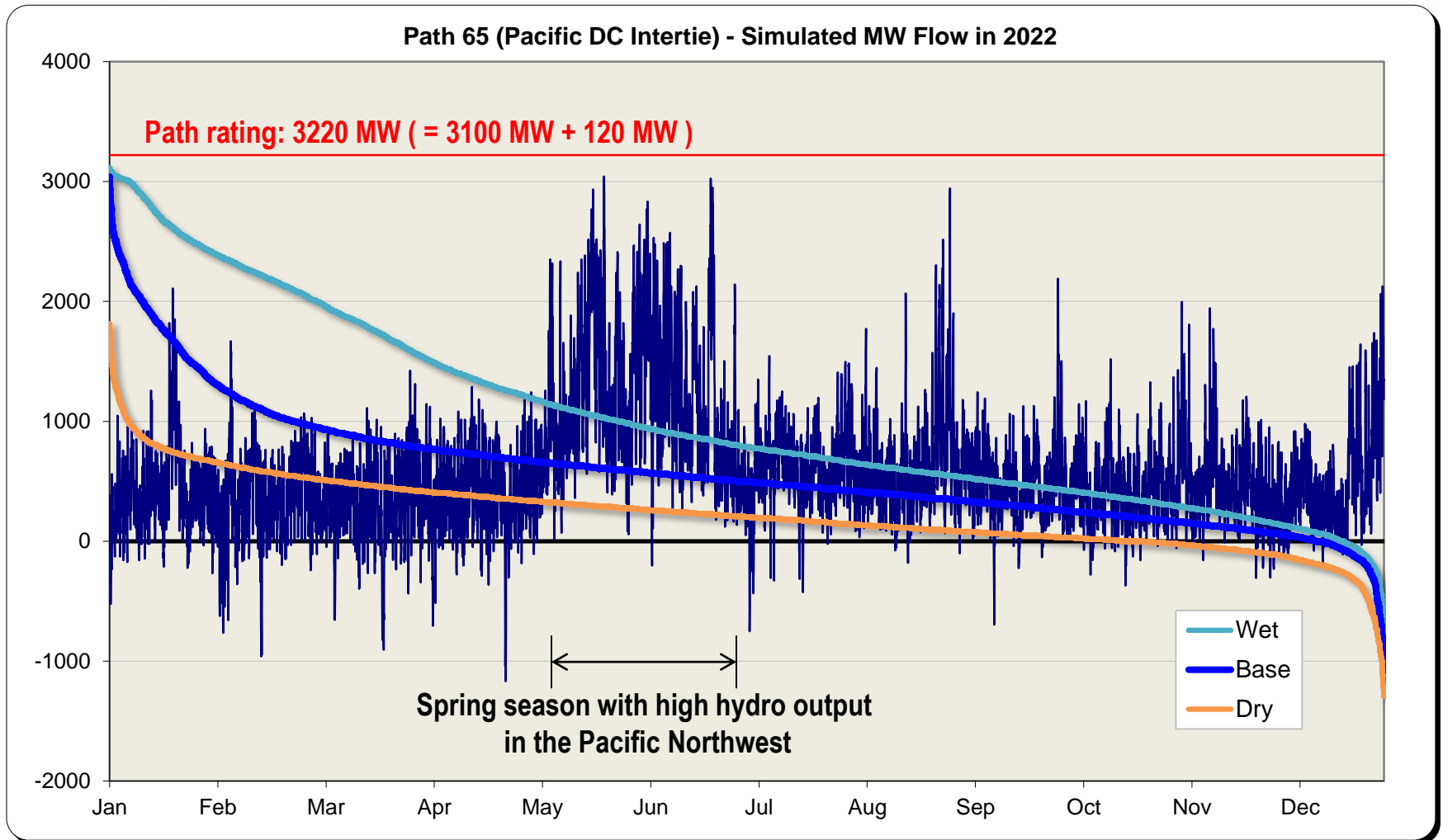


Simulated power flow on Path 66 (COI)

Path 66 (California-Oregon Intertie) - Simulated MW Flow in 2022



Simulated power flow on Path 65 (PDCI)



No congestion but prone to congestion during high hydro season

Conclusions and recommendations

Economic planning study for Pacific Northwest – California (NWC)

Economic assessment:

Alt	Description	Year	Capital cost	Total cost	Total benefit
1	Increase PDCI capacity by 500 MW	2022	> \$300M	\$435M	~0

Conclusion:

Insufficient economic justifications for the proposed upgrade

Comments:

Energy benefit is insignificant

Capacity benefit on system RA saving is limited because of downstream constraints

Capacity benefit on LCR saving is negative because of aggravated downstream constraints

Recommendation:

Due to the volumes of power transfer, COI and PDCI shall receive continued attention

This subject will be re-visited in future studies

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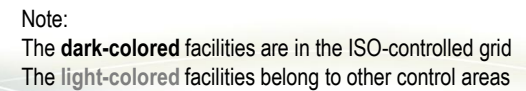
Study 4: Pacific Northwest - California (NWC)



Study 5: Desert Southwest - California (SWC)

Summary

Three alternatives studied



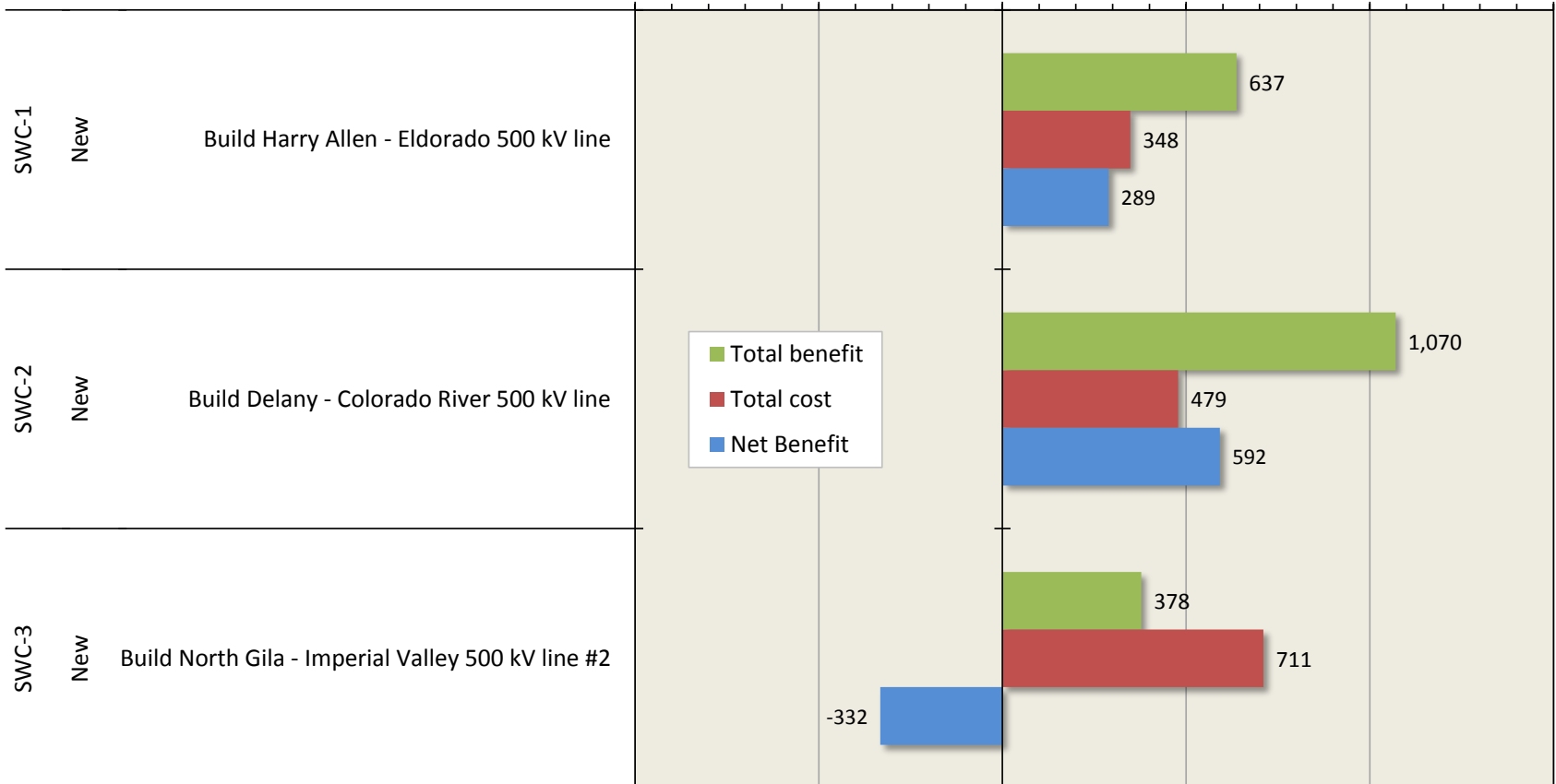
Economic assessment

Cost-benefit analysis of the three new 500 kV lines

Desert Southwest - California

Cost-benefit analysis - Million US dollars in 2012\$

-1,000 -500 0 500 1,000 1,500



Breakdown of the costs and benefits

Cost estimate

Alt.	Description	Capital cost	Total cost
1	Harry Allen – Eldorado 500 kV line (60 miles)	\$240M	\$348M
2	Delany – Colorado River 500 kV line (110 miles)	\$325M	\$471M
3	North Gila – Imperial Valley 500 kV line #2 (80 miles)	\$490M	\$711M

Note: The total cost is the total revenue requirement in net present value at the proposed operation year. The total revenue requirement includes impacts of capital cost, tax expenses, O&M expenses and other relevant costs. As a rough estimate, the total revenue requirement is estimated as the capital cost multiplied by a factor of 1.45 to represent a high-end cost estimate.

Actual revenue requirement varies based on specific financial assumptions of utilities or other entities

Benefit quantification

Alt.	Yearly benefits					Total benefit
	Year	Production	Capacity	Losses	Total	
1	2017	\$87M	\$0M	\$0M	\$87M	\$637M
	2022	\$33M	\$0M	\$0M	\$33M	
2	2017	\$68M	\$1M	\$2M	\$71M	\$1,070M
	2022	\$68M	\$1M	\$2M	\$71M	
3	2017	\$25M	\$1M	\$0M	\$29M	\$378M
	2022	\$24M	\$1M	\$0M	\$28M	

Note: See the next slide for a further breakdown of benefit components

Further breakdown of the economic benefits

Explanations of the yearly production, capacity and losses benefits

Harry Allen – Eldorado 500 kV

Delany – Colorado River 500 kV

North Gila – IV 500 kV line #2

Alt.	Year	Production		Consumer	Producer	Transmission
1	2017	\$87M	=	\$136M	-\$36M	-\$13M
	2022	\$33M	=	\$55M	-\$17M	-\$5M
2	2017	\$68M	=	\$78M	-\$5M	-\$5M
	2022	\$68M	=	\$69M	\$2M	-\$3M
3	2017	\$25M	=	\$37M	-\$10M	-\$2M
	2022	\$24M	=	\$32M	-\$7M	-\$1M

Computed by production simulation for 8,760 hours in each study year in comparison of “pre-project” and “post-project” cases

Alt.	Capacity		Calculation		Losses		Calculation
1	\$0M	=	$\$5/\text{kW}\cdot\text{year} \times 0 \text{ MW}$		\$0M	=	$0 \text{ MW} \times 8760 \text{ hours} \times (\$48.98/\text{MWh} + \$56.72/\text{MWh}) / 2$
2	\$1M	=	$\$5/\text{kW}\cdot\text{year} \times 200 \text{ MW}$		\$2M	=	$3.62 \text{ MW} \times 8760 \text{ hours} \times (\$48.98/\text{MWh} + \$56.72/\text{MWh}) / 2$
3	\$1M	=	$\$5/\text{kW}\cdot\text{year} \times 200 \text{ MW}$		\$0M	=	$0 \text{ MW} \times 8760 \text{ hours} \times (\$48.98/\text{MWh} + \$56.72/\text{MWh}) / 2$

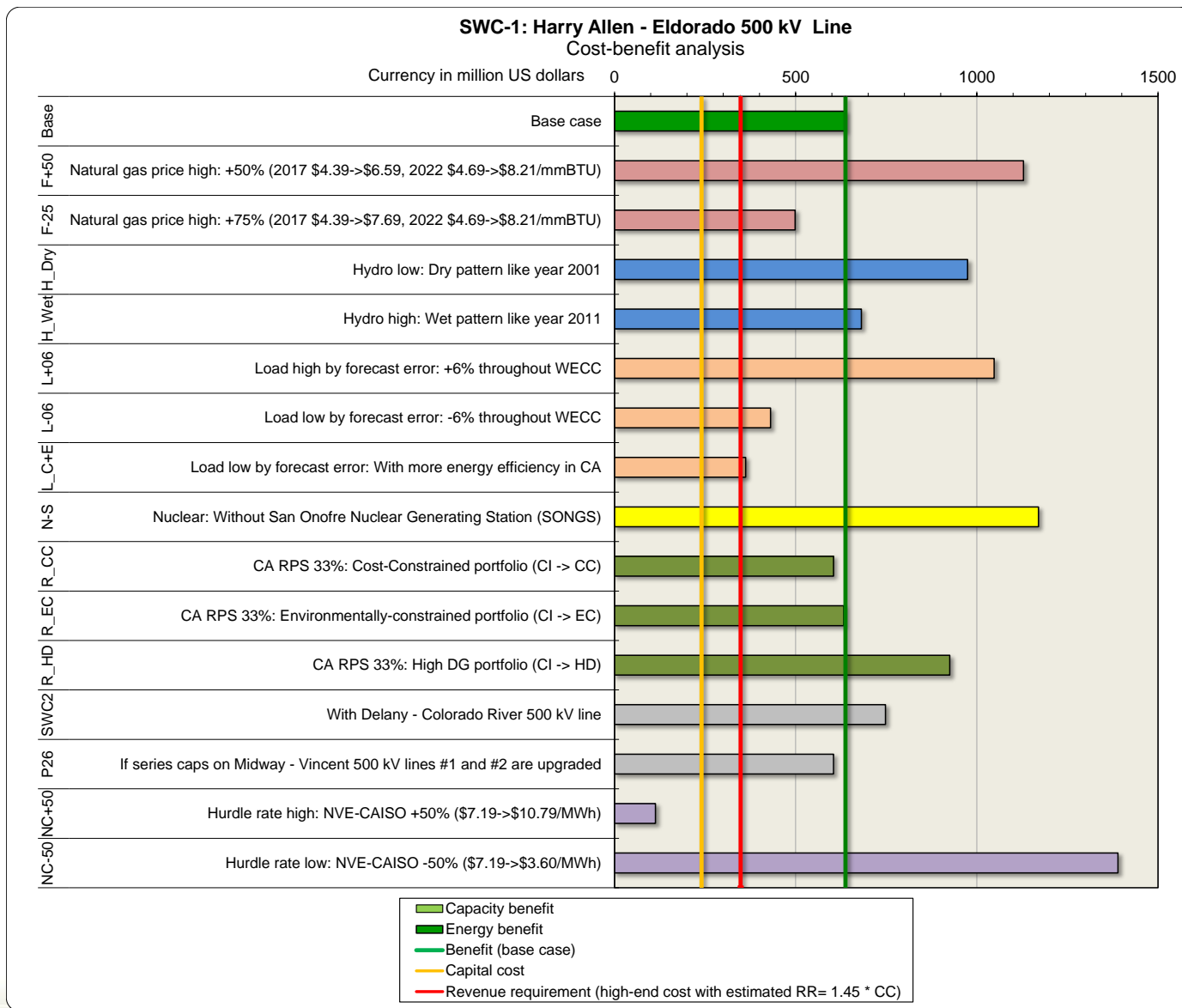
Assumed capacity price difference between California and out-of-state

Estimated increase of import capacity by deliverability analysis

Losses reduction calculated by power flow

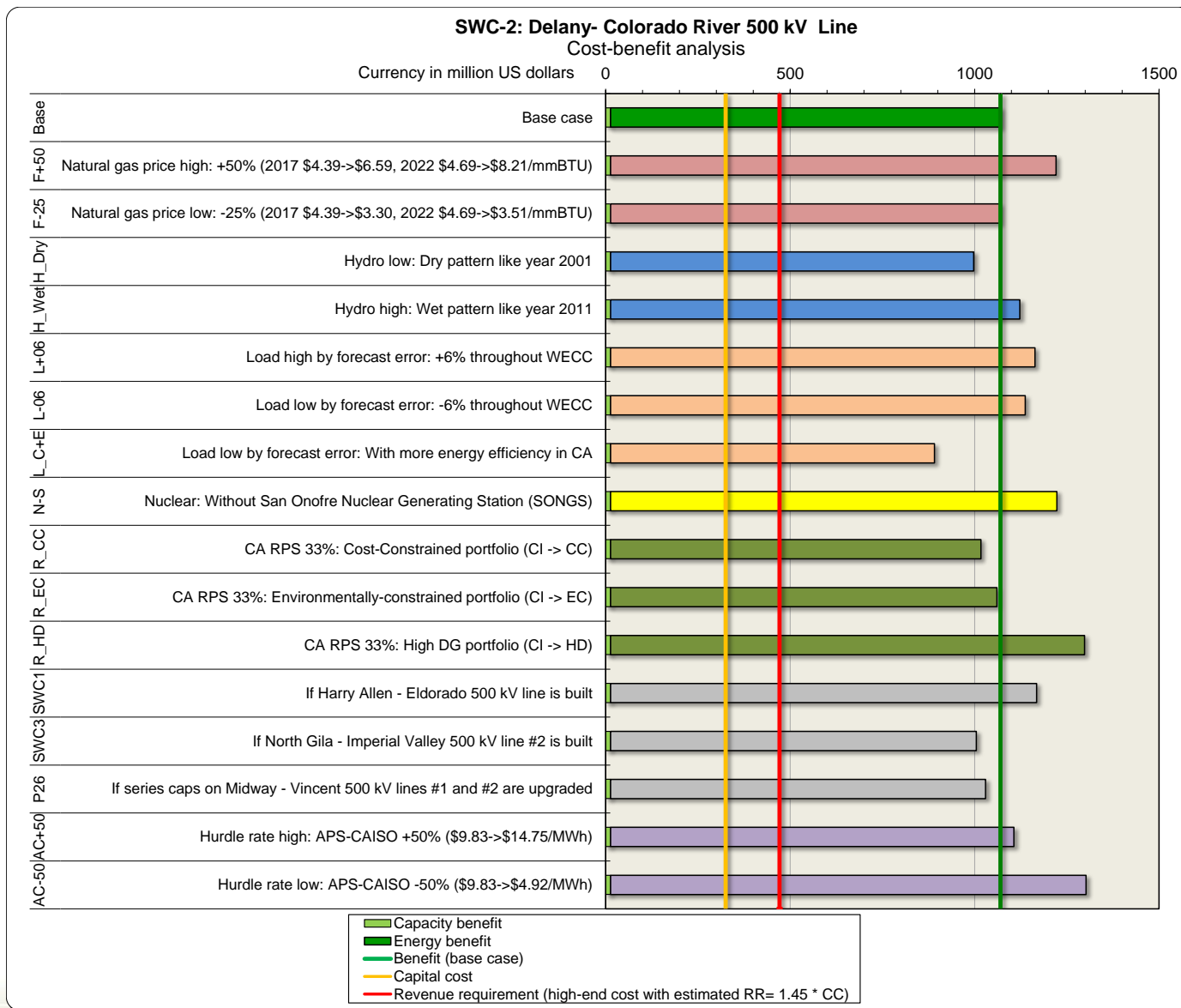
Average LMP in 2017 and 2022 in southern California

Sensitivity analysis: Harry Allen – Eldorado 500 kV line



Comments:
Significant benefits above the cost
With a certain degree of volatility

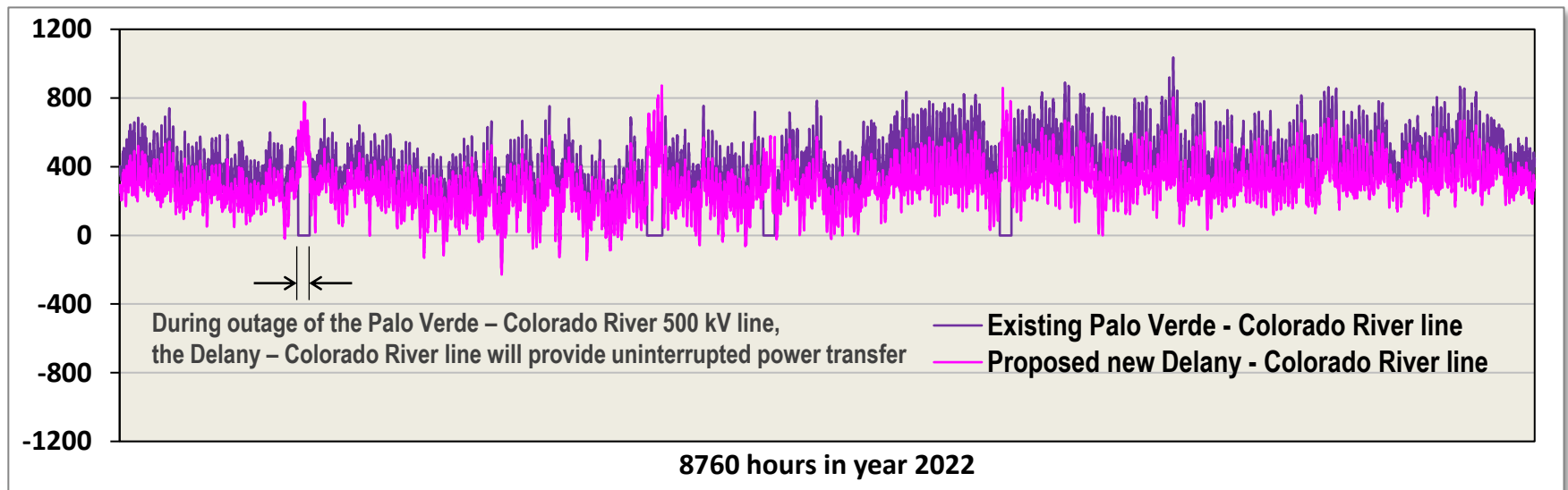
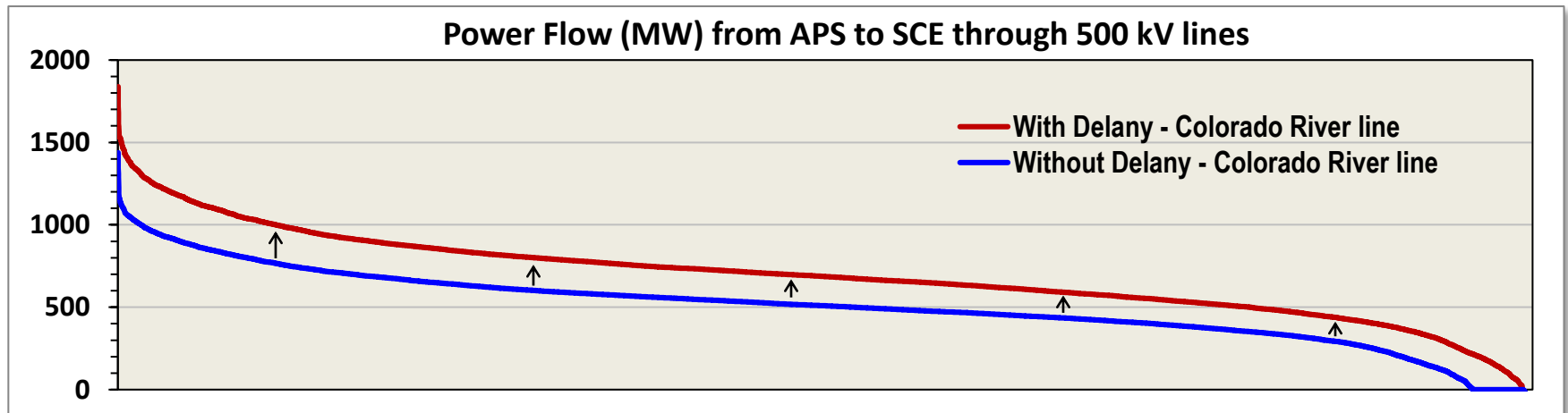
Sensitivity analysis: Delany – Colorado River 500 kV line



Comments:
Significant benefits with a large margin above the cost
Highly robust under a variety of conditions

Power flow from APS to SCE via 500 kV

Performance of Alternative 2 (Delany – Colorado River 500 kV line)



Conclusions and recommendations

Economic planning study for Desert Southwest – California (SWC)

Economic assessment:

Alt	Description	Year	Capital cost	Total cost	Total benefit
1	Harry Allen – Eldorado 500 kV line (60 miles)	2017	\$240M	\$348M	\$637M
2	Delany – Colorado River 500 kV line (110 miles)	2017	\$325M	\$479M	\$1,057M
3	North Gila – Imperial Valley 500 kV line #2 (80 miles)	2017	\$490M	\$711M	\$378M

Recommendations:

Harry Allen – Eldorado 500 kV line (from NVE to SCE)

The study found significant economic benefits

Recommendation: Further analysis in the on-going NVE-ISO Joint Study

Delany – Colorado River 500 kV line (from APS to SCE)

The study found significant and robust economic benefits

Recommendation: Project approval

North Gila – Imperial Valley 500 kV line (SDG&E)

The study found some economic benefits but the benefits are less than the estimated cost

Recommendation: Further analysis in the next planning cycle

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Summary

Study summary

- ❖ The ISO economic planning study identified transmission congestion in the ISO controlled grid through production simulation for 8,760 hours in each study year
- ❖ In evaluation of the identified grid congestion and with considerations of stakeholder study requests, the ISO constructed five high priority studies, where economic benefits were quantified for the proposed network upgrades
- ❖ Of the five high-priority studies, the first four studies did not find economic justifications for the studied network upgrades, while the fifth study found two network upgrades having significant economic benefits
- ❖ For the studied network upgrades that have significant benefits, comprehensive sensitivity analyses were made to account for planning uncertainties

Results summary

Evaluation of economic benefits to the ISO ratepayers

ID	Proposed congestion mitigation measures			Economic assessment			
	Alt.	Transmission Facilities	Op.Yr	Benefit	Cost	BCR	Comment
P26	1	Upgrade series caps on Midway – Vincent 500 kV lines #1 & #2	2017	~ 0	\$261M	-	Uneconomic
	2	Build Midway – Whirlwind 500 kV line #2 (80 miles)	2017	~ 0	\$580M	-	Uneconomic
	3	Build Midway – Vincent 500 kV #4 (110 miles)	2017	~ 0	\$1,595M	-	Uneconomic
LBN	1	Re-conductor Los Banos – Westley 230 kV line (35 miles)	2022	~ 0	\$65M	-	Uneconomic
	2	Open circuit for the Los Banos – Westley 230 kV line	2022	~ 0	\$0M	-	Uneconomic
CCA	$\Delta(P-G)$	Panoche – Gregg 230 kV line instead of Gates – Gregg line	2022	(\$14M)	\$0M	-	Uneconomic
	$\Delta(L-G)$	Los Banos – Gregg 230 kV line instead of Gates – Gregg line	2022	(\$115M)	\$145M	-	Uneconomic
NWC	1	Increase PDCI capacity by 500 MW	2017	~ 0	\$435M	-	Uneconomic
SWC	1	Harry Allen – Eldorado 500 kV line (60 miles)	2017	\$637M	\$348M	1.83	Economic
	2	Delany – Colorado River 500 kV line (110 miles)	2017	\$1,070M	\$471M	2.27	Economic
	3	North Gila – Imperial Valley 500 kV line #2 (80 miles)	2017	\$378M	\$711M	0.53	Uneconomic

Note:

The US dollars are in year 2012 values

The benefits and costs are net present values at the proposed operation year

The “benefit” is the total economic benefit determined by the economic planning study

The “cost” is the total revenue requirement that includes impacts of capital costs, tax expenses, O&M costs, etc.

For the CCA study, the listed dollars are *incremental* benefits and costs in comparison with the reference case

Recommendations

ISO Transmission Plan 2012-2013: Economic planning study

**The proposed Delany – Colorado River 500 kV line
is economically justified at this time and
is recommended for approval**

**The proposed Harry Allen – Eldorado 500 kV line
will receive further evaluation
as a part of an ongoing joint study with NV Energy**

Thanks!

Your questions and comments are welcome



For clarifying questions, please contact Xiaobo Wang at:
[\(916\) 608-1264](tel:9166081264), XBWang@caiso.com

For written comments, please send to:
RegionalTransmission@caiso.com