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# **STEP Powerflow Study Results**

**Presentation for STEP Group 08/29/2003**

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- Study focused on the 6 preferred STEP alternatives: 4 AC and 2 DC
- Peak and Off-Peak conditions studied
  - Peak; A summer peak day in the 2007-08 timeframe
  - Off-peak; late November, 2008, in the afternoon.
- Both cases have been reviewed by the utilities in the Southwest region
- Analysis of lower voltage transmission system included



## What the study included:

- Normal overloads (N-0)
- All single (N-1) contingencies (lines and transformers) 100 kV and above
- All credible double (N-2) contingencies 230 kV and above and G-2
- Post Transient voltage deviations (5% criteria for single contingencies and 10 % for double contingencies)

Study area covered Arizona, Nevada, CFE Mexico and S. California)



- Units that are normally not responsive to low frequency were modeled with base load flag set pr. WECC recommendation
- Proposed mitigation for identified criteria violations due to the proposed alternative or generation dispatch in the case (except for step-up transformers)
- Bipolar outage of DC line (alternative DC1 & DC2) is considered a double contingency



## What the study did not include:

- None of the WECC Path ratings in the Southwest were maximized
- Post transient reactive margin studies have not been performed yet
- Transient Stability work is in progress
- Mitigation for some N-2 contingencies



## **2007 Heavy Summer Peak Case:**

- Powerflow results have been presented before (230 kV and above)
- Represents an updated version of the case used in the screening study
- Solved with area interchange enabled
- CERS contracts for 2008 modeled



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## 2008 Off-Peak Case:

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- Based on data from the economic studies
  - Load
  - Generation
  - Flows
- Based on SCE's 2008 Spring Powerflow case developed this year (WECC starting case: Light Spring 2008, posted March 10, 2003)
- The case was sent out for review to the STEP Study Group
- Updates to the peak case incorporated (configuration)



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## 2008 Off-Peak Case:

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- Solved with area interchange enabled
- CERS contracts for 2008 modeled
- Existing Southern California market generation at reduced level; load served primarily by SONGS, QF's, new market generation and imports from the east
- Contingency files can be obtained by request



## Comparison Peak/Offpeak case:

New generation turned off in the off-peak case:

- Otay Mesa (558 MW)
- Moapa Duke (600 MW)
- Panda Power (520 MW)



## Comparison Peak/Off-peak case:

<b>Area (area#)</b>	<b>Load</b>		<b>Generation</b>		<b>Export</b>	
	<b>Peak</b>	<b>Off-Peak</b>	<b>Peak</b>	<b>Off-Peak</b>	<b>Peak</b>	<b>Off-Peak</b>
<b>Arizona (14)</b>	<b>16323</b>	<b>8968</b>	<b>22485</b>	<b>18622</b>	<b>5755</b>	<b>9364</b>
<b>IID (21)</b>	<b>814</b>	<b>570</b>	<b>1000</b>	<b>784</b>	<b>146</b>	<b>169</b>
<b>LADWP (26)</b>	<b>6269</b>	<b>4112</b>	<b>4593</b>	<b>2185</b>	<b>-2040</b>	<b>-2226</b>
<b>CFE (20)</b>	<b>2108</b>	<b>1542</b>	<b>2305</b>	<b>2163</b>	<b>163</b>	<b>714</b>
<b>Nevada Power (18)</b>	<b>5800</b>	<b>3000</b>	<b>4995</b>	<b>3761</b>	<b>-891</b>	<b>716</b>
<b>San Diego (22)</b>	<b>4769</b>	<b>3118</b>	<b>2305</b>	<b>1386</b>	<b>-2627</b>	<b>-2001</b>
<b>SCE (24)</b>	<b>21552</b>	<b>13651</b>	<b>12339</b>	<b>5770</b>	<b>-9775</b>	<b>-8368</b>
<b>WAPA (19)</b>	<b>138</b>	<b>140</b>	<b>4629</b>	<b>2226</b>	<b>4369</b>	<b>1965</b>



## Comparison Peak/Off-peak case:

<b>Interface</b>	<b>Flows (no projects)</b>		<b>Current Rating (WECC 2003 Path Rating Catalog)</b>
	<b><i>Peak</i></b>	<b><i>Off-Peak</i></b>	
<b>COI (P-66)</b>	<b>3993</b>	<b>650</b>	<b>4800</b>
<b>PDCI (P-65)</b>	<b>934</b>	<b>394</b>	<b>3100</b>
<b>Path 15</b>	<b>1398</b>	<b>786</b>	<b>3900</b>
<b>North to South CA (P-26)</b>	<b>2616</b>	<b>-740</b>	<b>3000</b>
<b>West of River (P-46)</b>	<b>8676</b>	<b>11428</b>	<b>10,118</b>
<b>East of River (P-49)</b>	<b>7166</b>	<b>9654</b>	<b>7550</b>
<b>South of SONGS (P-44)</b>	<b>1049</b>	<b>27</b>	<b>2200</b>
<b>Miguel Import</b>	<b>3140</b>	<b>2817</b>	<b>1400</b>
<b>West of Devers</b>	<b>1696</b>	<b>2531</b>	<b>Not rated</b>
<b>Palo Verde East</b>	<b>5906</b>	<b>5103</b>	<b>4629</b>
<b>Navajo South (P-51)</b>	<b>312</b>	<b>-613</b>	<b>2264</b>
<b>CFE to US (P-45)</b>	<b>163</b>	<b>562</b>	<b>800</b>



## **Sub-areas impacted by most of the proposed transmission alternatives/generation dispatch:**

- West of Devers (SCE)
- North and West of Miguel Substation (SDG&E)
- Sycamore Canyon area (SDG&E)
- West and South of Blythe  
(IID/WAPA/APS/MWD)
- Lines parallel to Imperial Valley - Miguel 500 kV  
line (CFE)



## **Other identified N-0 & N-1 overloads common to most of the alternatives:**

- Thunderstone – Santan 230 kV line (N-1)
- Victorville and Toluca 500 kV transformers (T-1)
- Mirage – Tamarisk 115 kV line (N-0, N-1)
- Westwing – Perkins 500 kV line (N-1)
- Imperial Valley 500/230 kV 600 MVA transformer (T-1)
- Overload of parallel 500/230 kV transformer bank at Devers and Miguel (T-1)

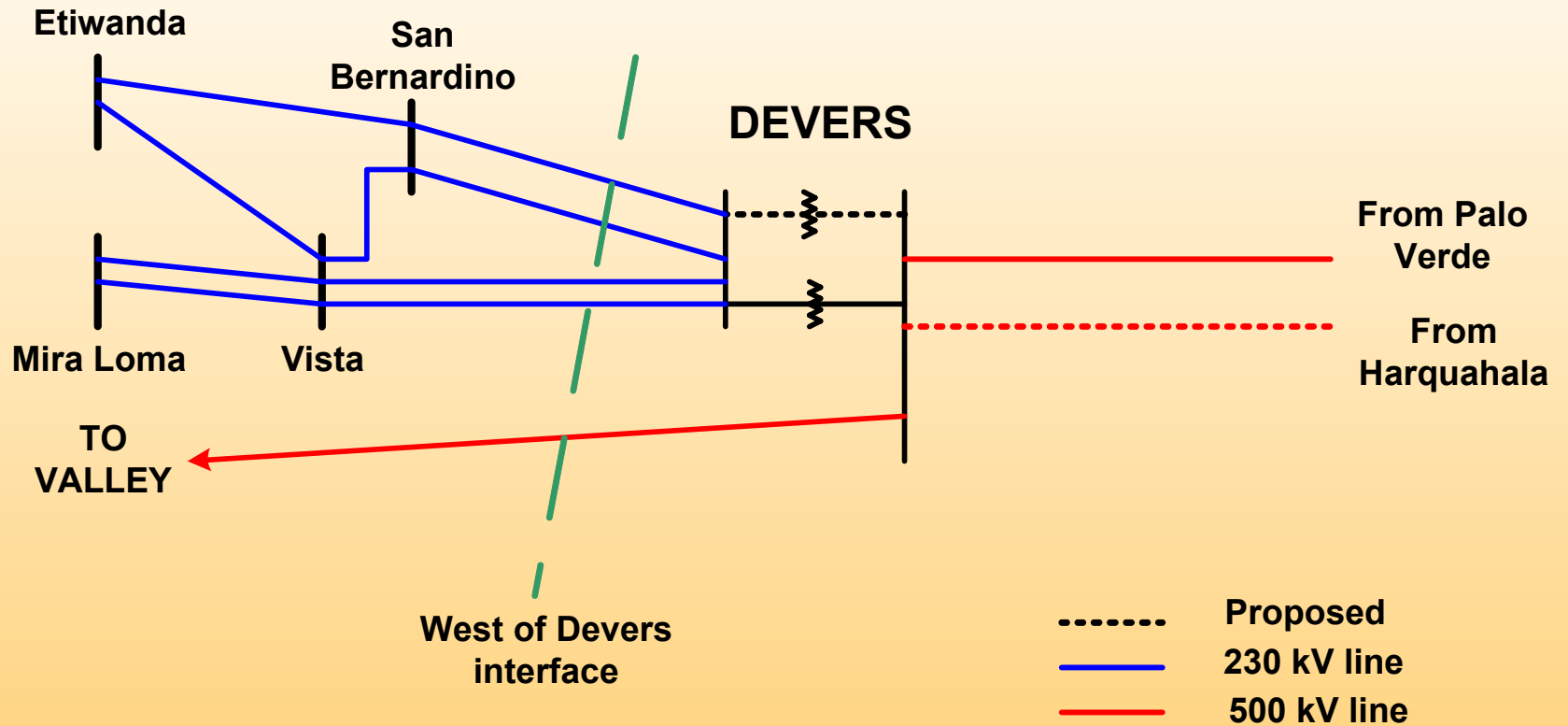


## **N-2 overloads common to most of the alternatives:**

- Load & generation dropping implemented for loss of Harquahala (Blythe) – Devers and Palo Verde – Devers 500 kV lines
- Loss of Miguel – Mission No. 1 & 2 overloads several SDG&E lines
- Loss of San Onofre – Santiago No. 1 & 2 overloads Barre – Ellis 230 kV line



## West of Devers





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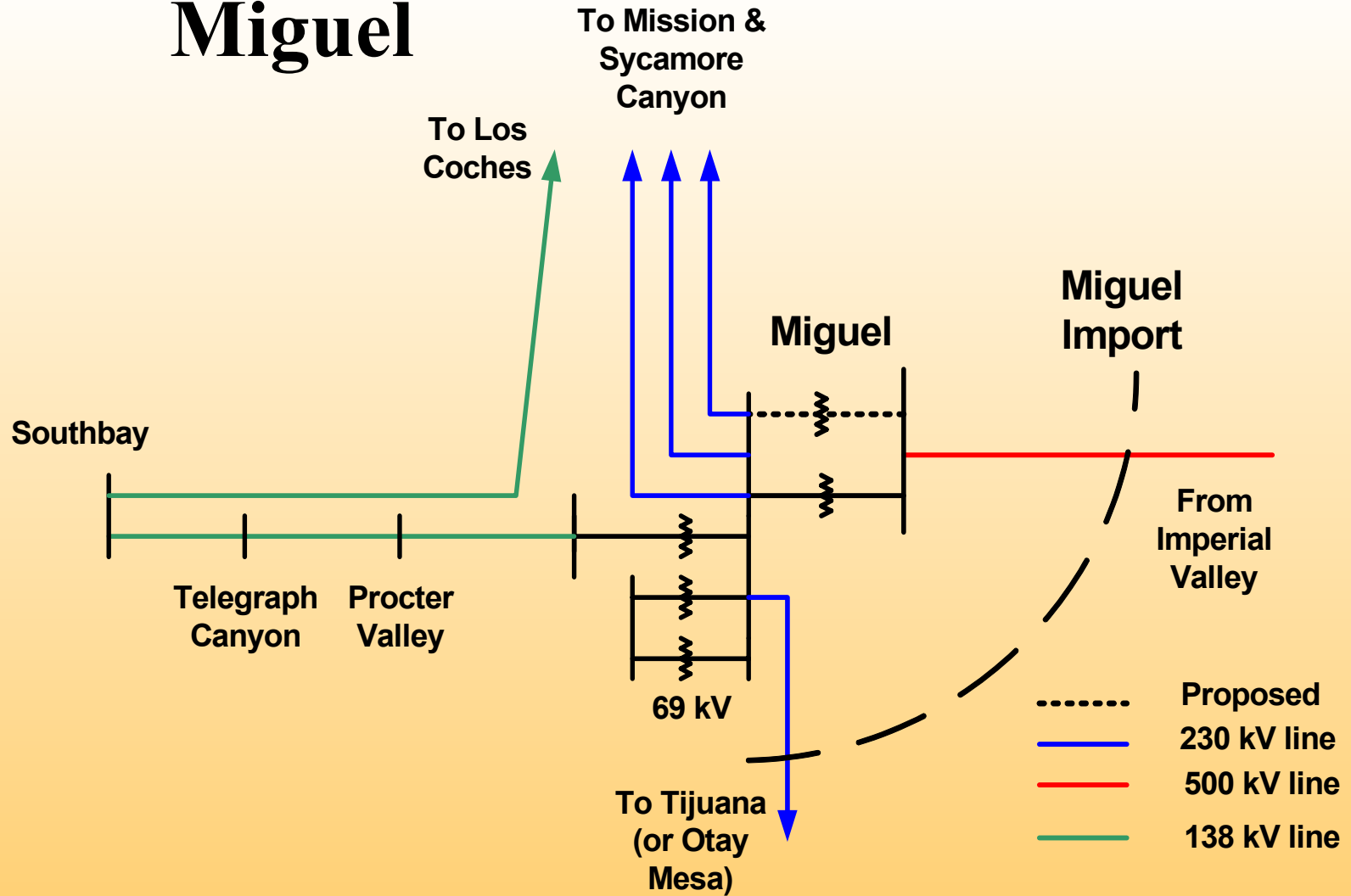
## West of Devers

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- Flow vary from 920 MW (DC1 Peak) to 4387 MW (AC2 Off-Peak)
- Possible mitigation:
  - Devers – Mira Loma 500 kV line
  - Reconductor the 4 230 kV lines west of Devers with 2B-1033 ACSR (normal rating 988 MV, N-1 rating 1135 MVA)
  - Devers – Valley No. 2 500 kV line



## Miguel



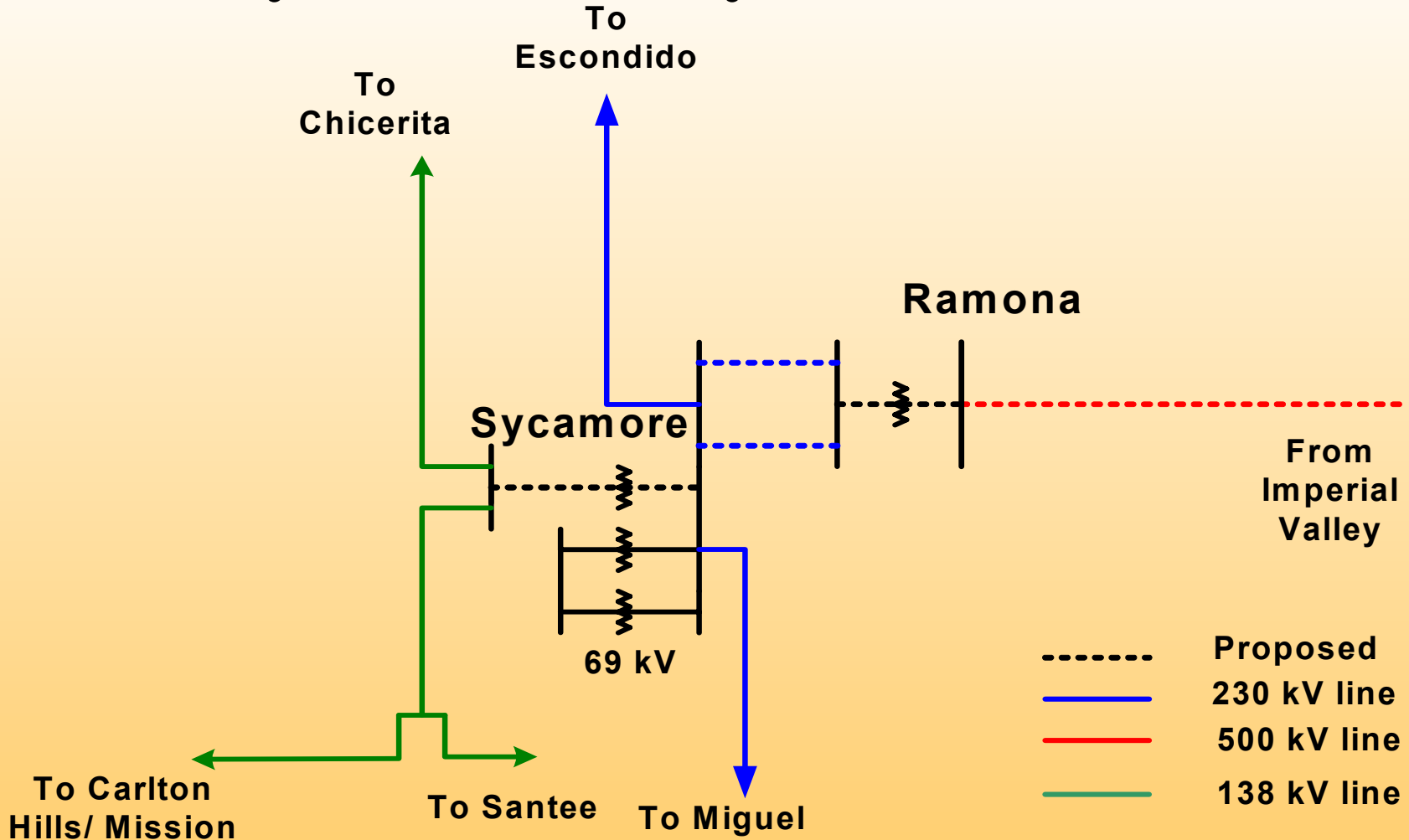


## Miguel

- Miguel Import vary from 1762 MW (DC1 Off-Peak) to 2362 MW (AC2 Peak)
- Possible mitigation:
  - Dispatch of Southbay generation
  - Loop existing Southbay – Los Coches 138 kV line into Miguel, reconductor.
  - Miguel – Southbay 230 kV ?



## Sycamore Canyon



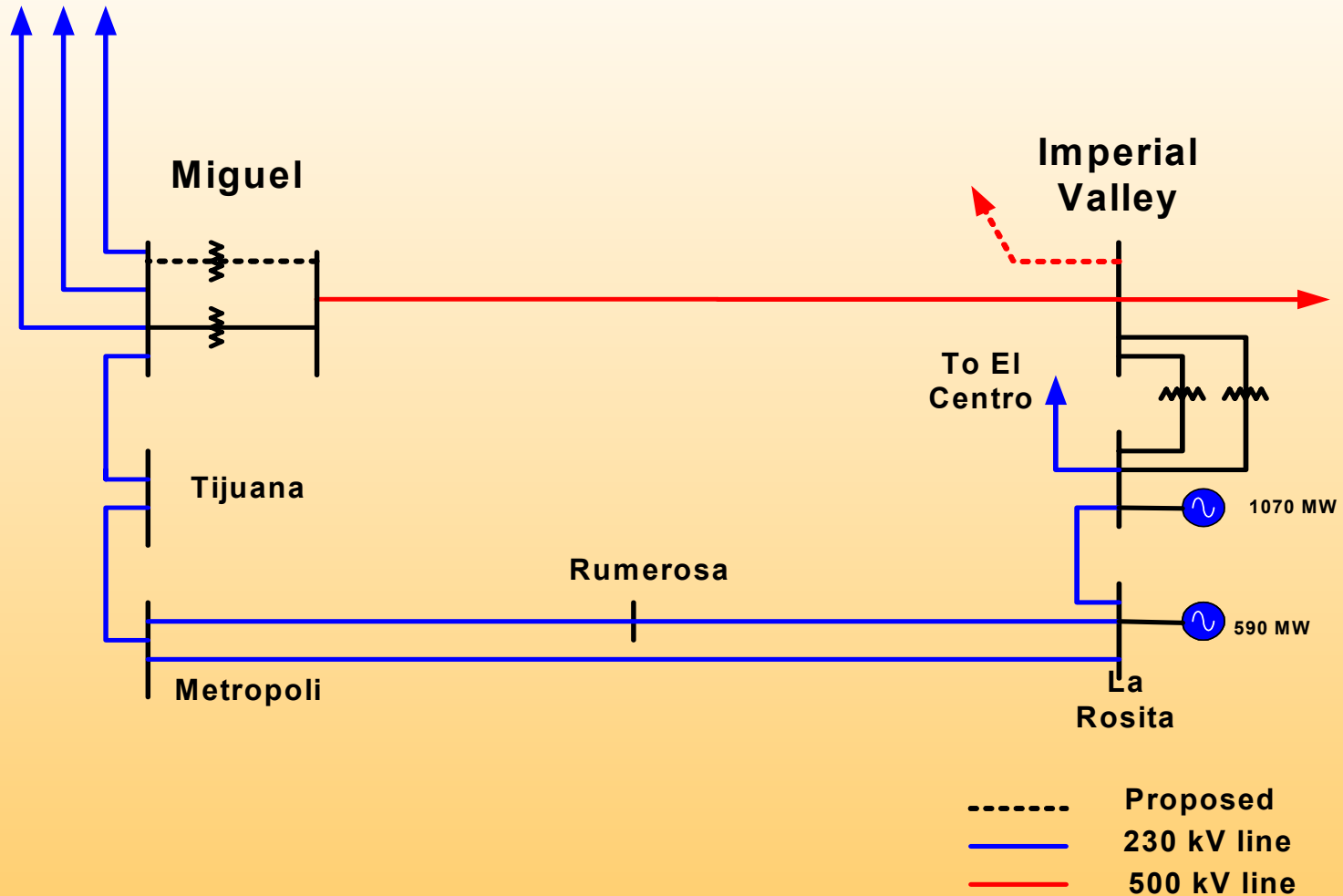


## Sycamore Canyon

- Flow on Imperial Valley – Ramona 500 kV line vary from 917 MW (DC1 Peak) to 1052 MW (AC4 Off-Peak)
- Possible mitigation:
  - Construct Sycamore Canyon – Penasquitos 230 kV line, install third 230/69 kV bank and increase N-1 rating on Sycamore Canyon – Carlton Hills Tap 138 kV
  - Install second 230/138 kV transformer and third 230/69 kV transformer, reconductor 138 kV lines.
  - Sycamore Canyon – Mission 230 kV ?



## Loss of Imperial Valley – Miguel 500 kV line





## Loss of Imperial Valley – Miguel 500 kV line

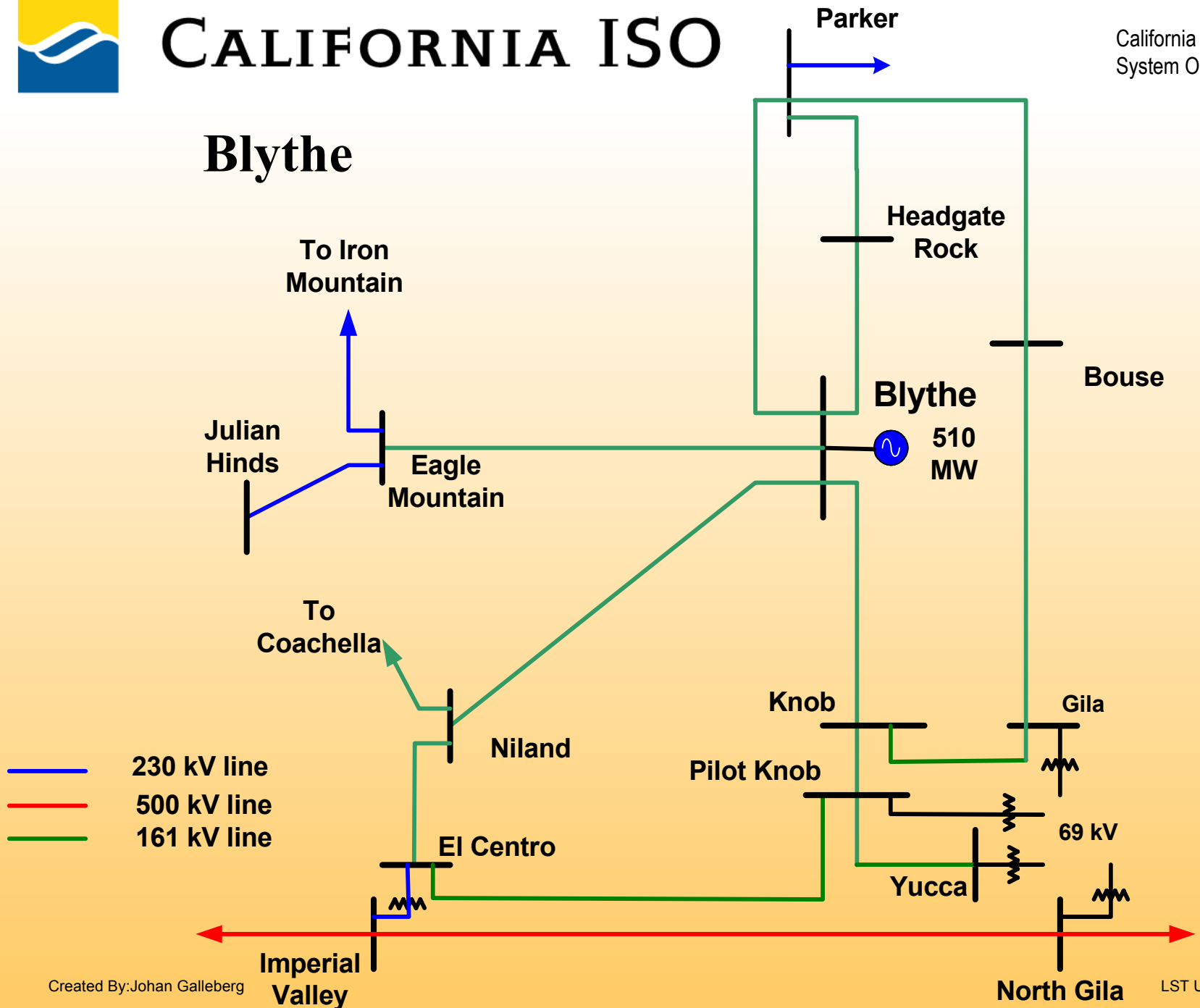
- Flow on Imperial Valley – Miguel 500 kV line vary from 1381 MW (DC1 Peak) to 1686 MW (AC2 Off-Peak)
- Limited by the N-1 rating on the 230 kV line from La Rosita to Rumerosa.
- Possible mitigation:
  - Trip generation at Imperial Valley
  - Trip generation at La Rosita
  - Cross-trip Imperial Valley – La Rosita 230 kV line



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## Blythe



- 230 kV line
- 500 kV line
- 161 kV line



## Blythe

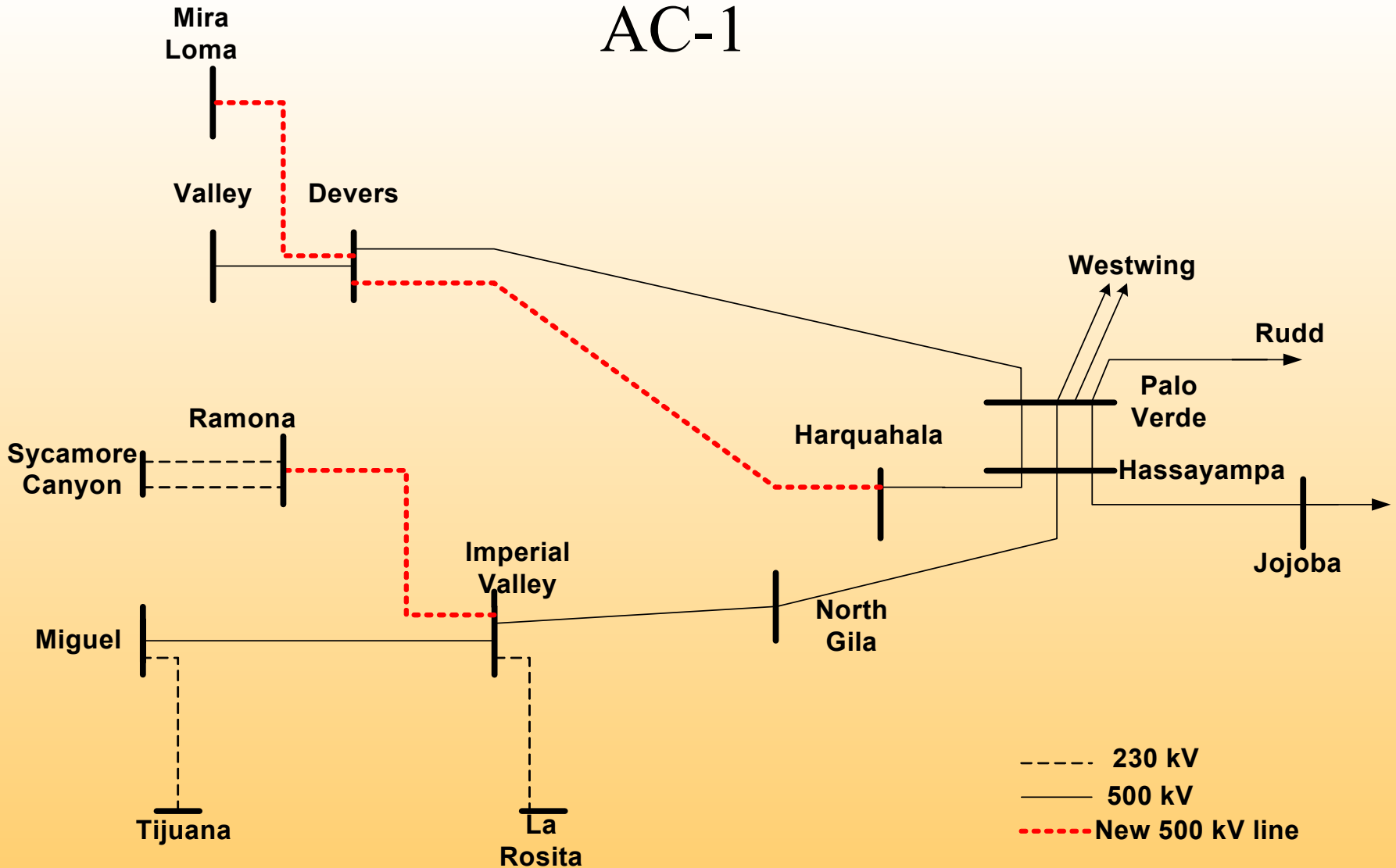
- Identified contingency overloads west and south of Blythe are a function of generation in the Blythe area and high east to west flow
- Possible mitigation:
  - Trip generation in the Blythe area under contingency conditions, voltage support in the Yuma area
  - Increase N-1 ratings on several lines, add a 161/69 kV transformer at Yucca and Gila and voltage support in the Yuma area
  - New generation in the Yuma area (?)



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## AC-1





## Mitigation AC1

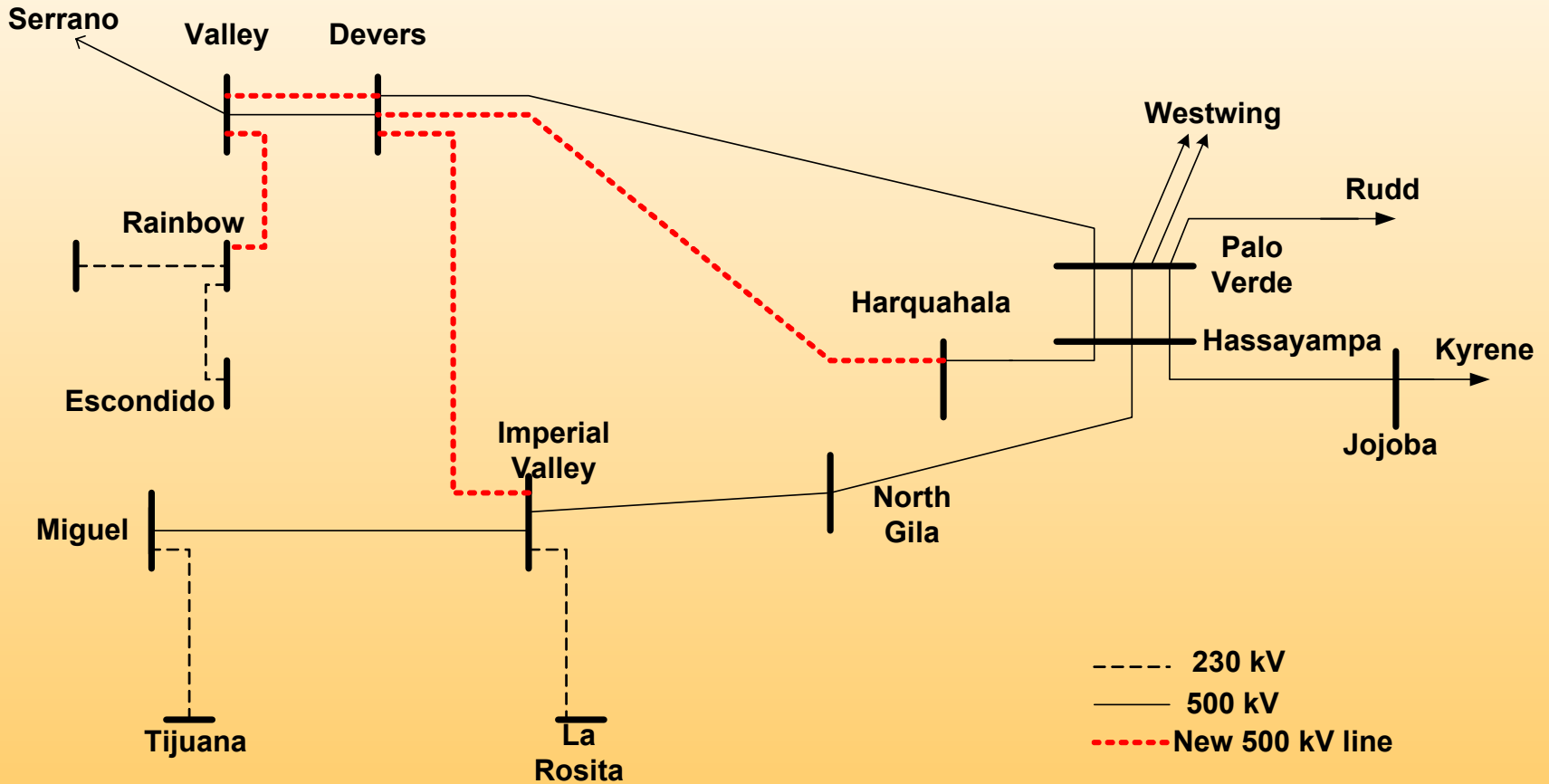
- 500 kV Series Capacitor upgrade:
  - SWPL
  - Navajo – Crystal
  - Palo Verde – Devers
- Mitigation for identified N-0 & N-1 overloads West of Devers, Miguel, Sycamore Canyon, Blythe and for loss of Imperial Valley – Miguel 500 kV line
- N-2 contingency analysis:
  - N-2 of Harquahala – Devers and Palo Verde – Devers 500 kV lines
  - N-2 of Miguel – Mission No. 1 & 2 230 kV lines
  - N-2 of San Onofre – Santiago No. 1 & 2 230 kV lines
- Voltage support needed at Devers, IID, Southbay & Yuma areas



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## AC-2





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- Very high West of Devers flow
- Phase shifter at Rainbow (1120 MVA, +/- 25 degrees)
- Phase shifters on Imperial Valley – Devers 500 kV line, 2 x 650 MVA, +/- 24 degrees
- 500 kV Series Capacitor upgrade:
  - SWPL
  - Navajo – Crystal
  - Palo Verde – Devers
- Mitigation for identified N-0 & N-1 overloads West of Devers, Miguel, Blythe and for loss of Imperial Valley – Miguel 500 kV line



# CALIFORNIA ISO Mitigation AC2

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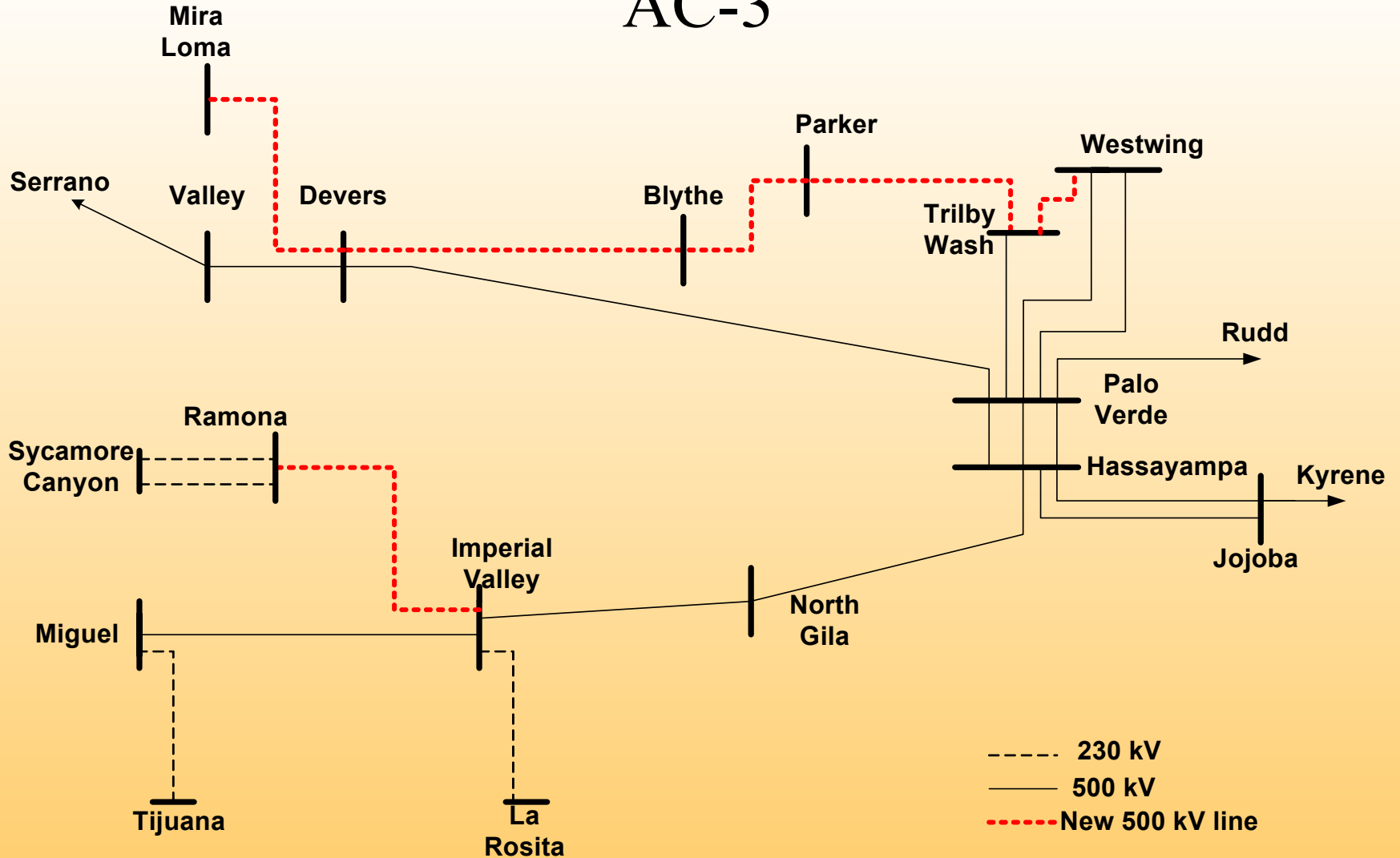
- N-2 contingency analysis:
  - N-2 of Harquahala – Devers and Palo Verde – Devers 500 kV lines
  - N-2 of Miguel – Mission No. 1 & 2 230 kV lines
  - N-2 of San Onofre – Santiago No. 1 & 2 230 kV lines
- Voltage support needed at Devers, IID, Rainbow, Southbay & Yuma areas



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## AC-3





## Mitigation AC3

- 500 kV Series Capacitor upgrade:
  - SWPL
  - Navajo – Crystal
  - Palo Verde – Devers
- Mitigation for identified N-0 & N-1 overloads West of Devers, Miguel, Sycamore Canyon, and for loss of Imperial Valley – Miguel 500 kV line
- Blythe 500 kV connection reduces the impacts on the Blythe area transmission system. Trip Buck Blvd. – Blythe 161 kV line under certain contingencies ?



## Mitigation AC3

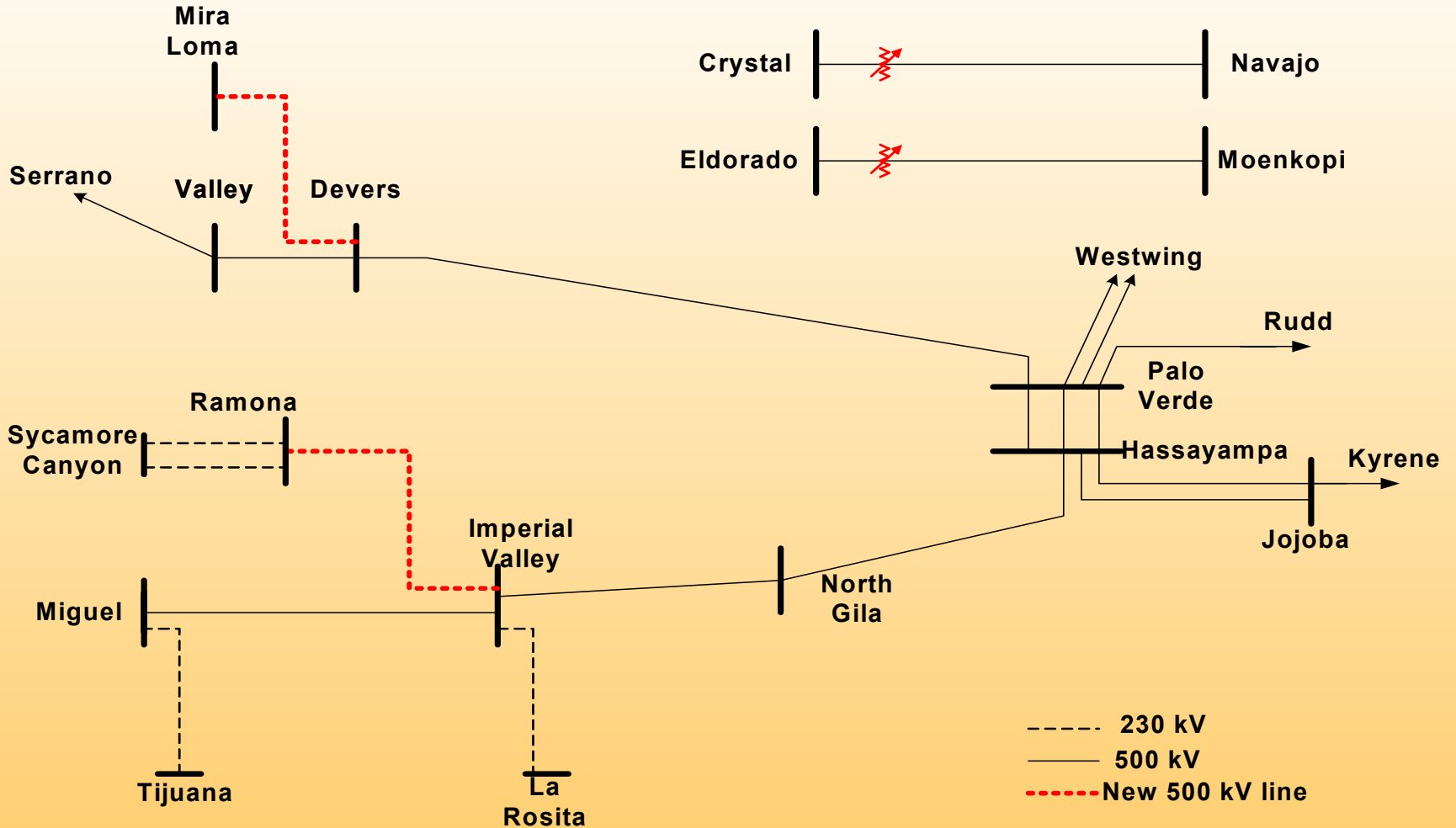
- N-2 contingency analysis:
  - N-2 of Blythe – Devers and Palo Verde – Devers 500 kV lines
  - N-2 of Miguel – Mission No. 1 & 2 230 kV lines
  - N-2 of San Onofre – Santiago No. 1 & 2 230 kV lines
- Voltage support needed at Devers, IID, Southbay & Yuma areas



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## AC-4





## Mitigation AC4

- Phase-shifters;
  - Navajo – Crystal 500 kV line: 3 x 650 MVA, 0-32 degrees
  - Moenkopi - Eldorado 500 kV line: 3 x 650 MVA, 0-32 degrees
  - Perkins - Mead 500 kV line: 1 additional phase shifter identical to the two existing ones (650 MVA, +/-24 degrees)
  - N-1 rating each phase shifter; 875 MVA
- 500 kV Series Capacitor upgrade:
  - SWPL
  - Navajo – Crystal
  - Palo Verde – Devers
  - Moenkopi – Eldorado
  - Eldorado – Lugo
  - Perkins - Mead



## Mitigation AC4

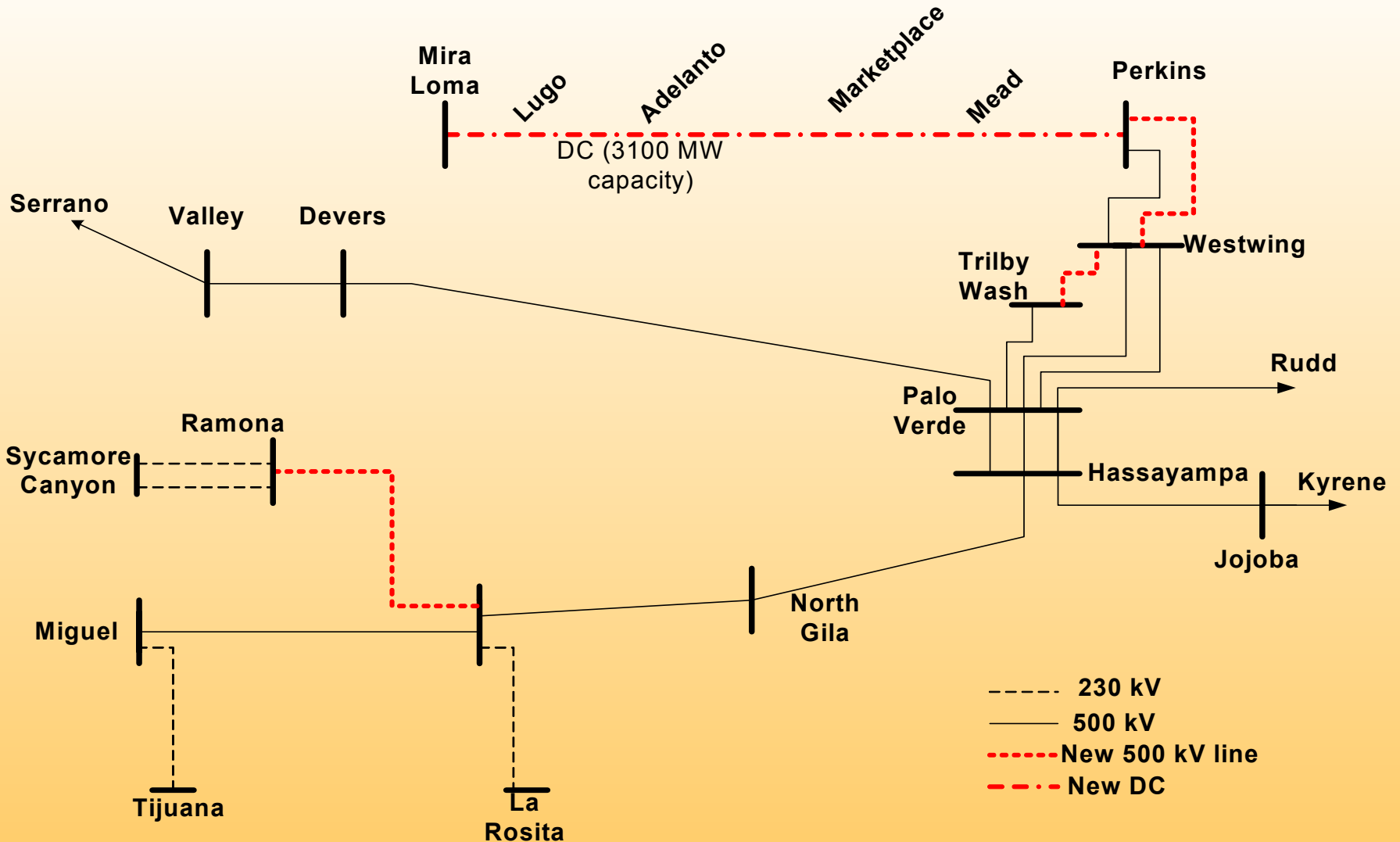
- 2 “new” normal overloads:
  - Blythe – Eagle Mountain 161 kV line
  - Blythe – Knob 161 kV line
- Mitigation for identified N-0 & N-1 overloads West of Devers, Miguel, Sycamore Canyon, Blythe and for loss of Imperial Valley – Miguel 500 kV line
- N-2 contingency analysis:
  - N-2 of South of Lugo 500 kV lines
  - N-2 of Miguel – Mission No. 1 & 2 230 kV lines
  - N-2 of San Onofre – Santiago No. 1 & 2 230 kV lines
  - N-2 of McCullough – Victorville No. 1&2 500 kV lines
- Voltage support needed at Devers, Mira Loma, IID, Southbay, Eldorado, Crystal, Adelanto & Yuma areas



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## DC-1





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## Mitigation DC1

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- 500 kV Series Capacitor upgrade:
  - SWPL
  - Navajo – Crystal
  - Palo Verde – Devers
  - Moenkopi – Eldorado



## Mitigation DC1

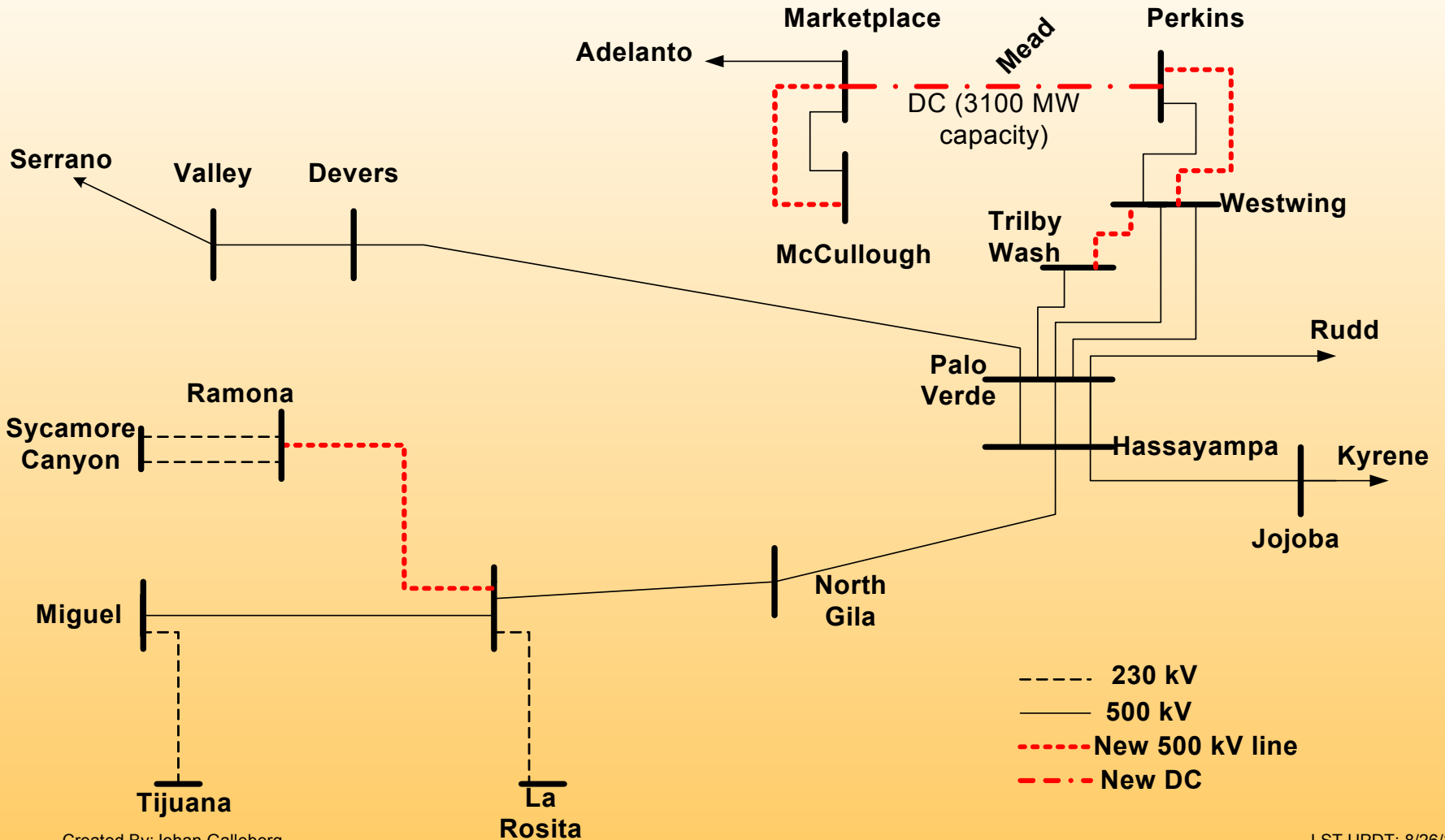
- Re-conductoring of Devers – San Bernardino No.1 230 kV line needed (West of Devers)
- Mitigation for identified N-0 & N-1 overloads Miguel, Sycamore Canyon, Blythe and for loss of Imperial Valley - Miguel 500 kV line
- N-2 contingency analysis:
  - Loss of DC line overloads Liberty – Peacock 345 kV line
  - N-2 of Miguel – Mission No. 1 & 2 230 kV lines
  - N-2 of San Onofre – Santiago No. 1 & 2 230 kV lines
- Voltage support needed at Devers, Mira Loma, IID, Southbay, Eldorado & Yuma areas



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## DC-2





## Mitigation DC2

- 500 kV Series Capacitor upgrade:
  - SWPL
  - Palo Verde – Devers
- Re-conductoring of Devers – San Bernardino No.1 230 kV line needed (West of Devers)
- High impact on Blythe/IID system for various contingencies

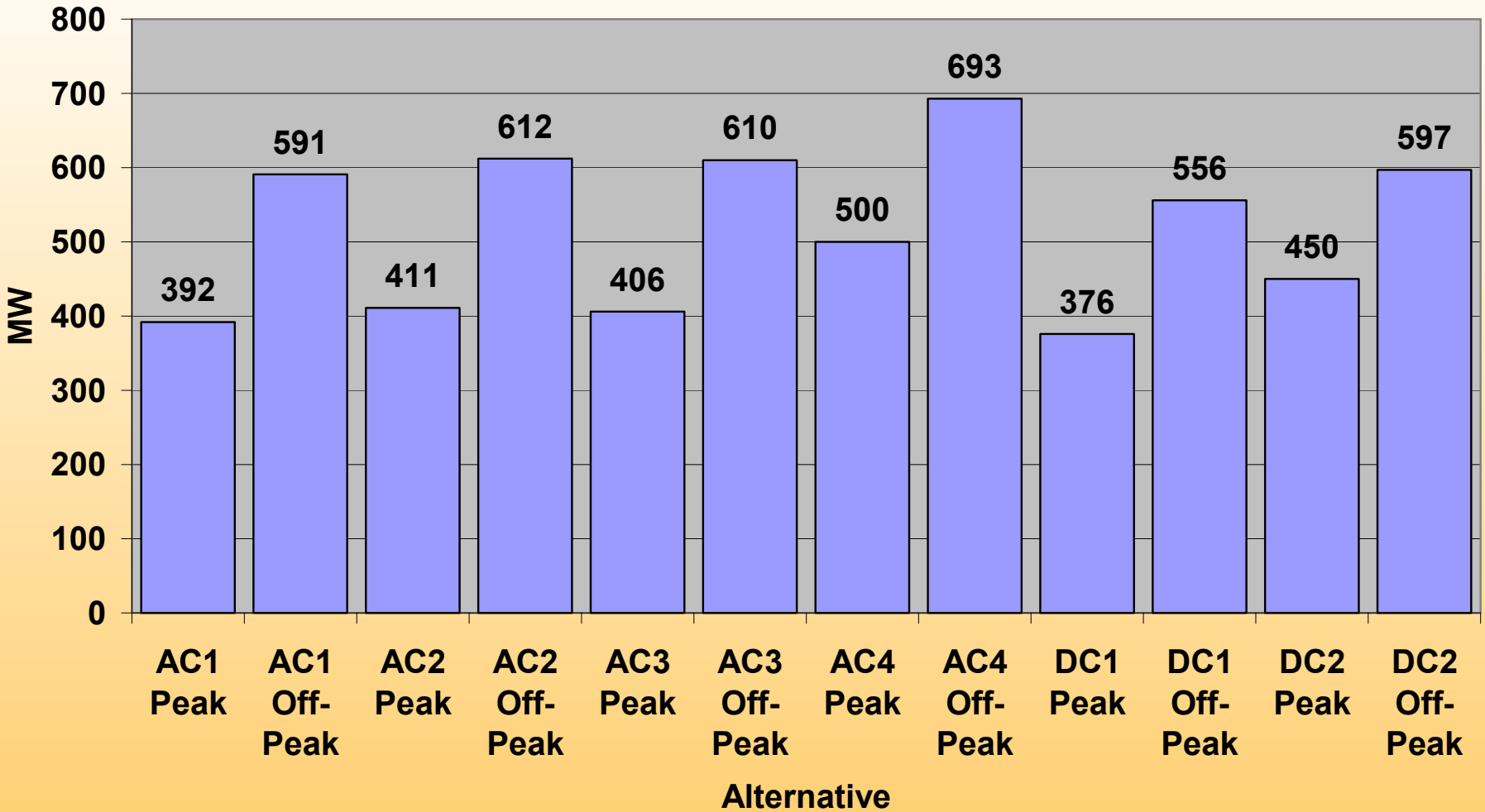


## Mitigation DC2

- Mitigation for identified N-0 & N-1 overloads, Miguel, Sycamore Canyon, Blythe and for loss of Imperial Valley
  - Miguel 500 kV line
- N-2 contingency analysis:
  - Loss of DC line overloads Liberty – Peacock 345 kV line and Liberty phase shifter
  - N-2 of South of Lugo 500 kV lines
  - N-2 of Miguel – Mission No. 1 & 2 230 kV lines
  - N-2 of San Onofre – Santiago No. 1 & 2 230 kV lines
  - N-2 of McCullough – Victorville No. 1&2 500 kV lines
- Voltage support needed at Devers, Mira Loma, IID, Southbay, Eldorado, Mohave & Yuma areas



## MW Losses 500 kV lines Southwest (area 1-26)





## MVAR requirement for each alternative (ballpark numbers)

