Integration of 75MW Solar PV Plant: Transmission System Design Analysis

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Project Objectives

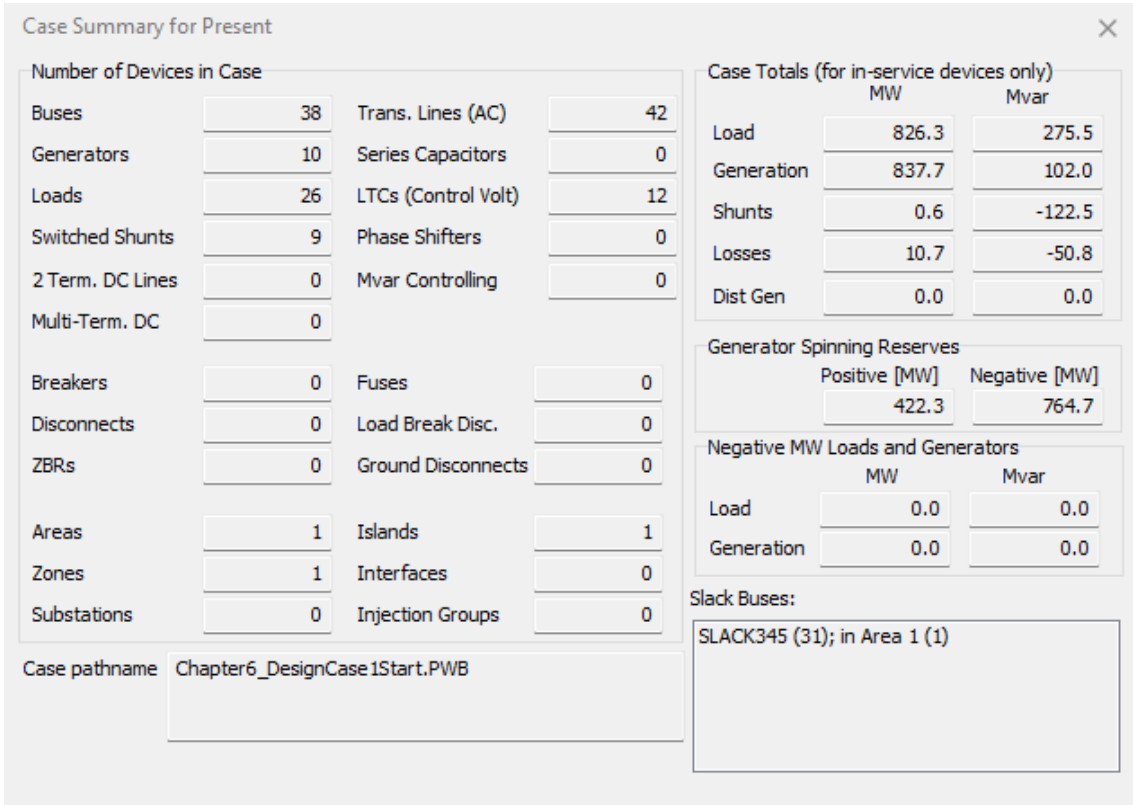
Design transmission system modifications to:

- Integrate 75 MW solar PV at NEWSOLAR substation
- Provide redundant transmission paths
- Resolve existing system violations
- Maintain stability under N-1 contingency
- Minimize total cost including 5-year loss reduction

Initial System Analysis

Base System Characteristics:

- Total load: 826.3 MW, 275.5 Mvar
- Generation: 837.7 MW from 10 generators
- System losses: 10.7 MW (1.3%)
- Reactive support: -122.5 Mvar from 9 switched shunts


Case Summary for Present

Number of Devices in Case

Buses	38	Trans. Lines (AC)	42
Generators	10	Series Capacitors	0
Loads	26	LTCs (Control Volt)	12
Switched Shunts	9	Phase Shifters	0
2 Term. DC Lines	0	Mvar Controlling	0
Multi-Term. DC	0		
Breakers	0	Fuses	0
Disconnects	0	Load Break Disc.	0
ZBRs	0	Ground Disconnects	0
Areas	1	Islands	1
Zones	1	Interfaces	0
Substations	0	Injection Groups	0

Case pathname: Chapter6_DesignCase1Start.PWB

Case Totals (for in-service devices only)

	MW	Mvar
Load	826.3	275.5
Generation	837.7	102.0
Shunts	0.6	-122.5
Losses	10.7	-50.8
Dist Gen	0.0	0.0

Generator Spinning Reserves

Positive [MW]	Negative [MW]
422.3	764.7

Negative MW Loads and Generators

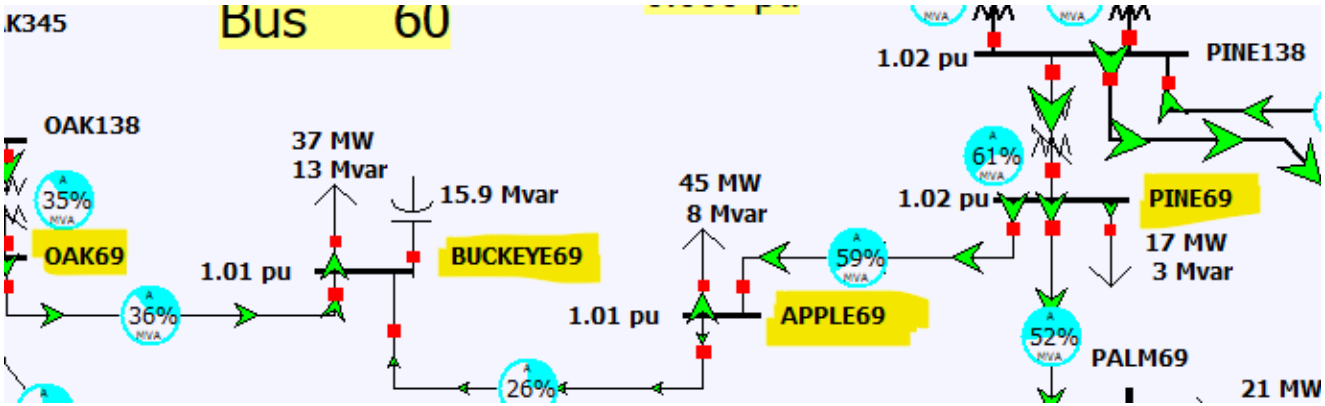
	MW	Mvar
Load	0.0	0.0
Generation	0.0	0.0

Slack Buses:

SLACK345 (31); in Area 1 (1)

Existing System Violations

Contingency	Flow	Limit	%
PINE138-PINE69 Xfmr:			
OAK69-BUCKEYE69	760.3	686.1	110.8
BUCKEYE69-APPLE69	454.2	418.4	108.6



Design Approach

- Evaluate all possible connection configurations
- Compare 69 kV vs 138 kV options
- Start with shortest distance solution
- Use least expensive conductors initially
- Upgrade components only as needed
- Consider loss reduction benefits

Candidate Solutions

19 possible configurations evaluated:

- 69 kV options: \$5.94M - \$12.23M
- 138 kV options: \$14.37M - \$19.42M
- Shortest path: NEWSOLAR to BUCKEYE69 & APPLE69 (12 km)
- Required upgrade: OAK69-BUCKEYE69 to Crow conductor

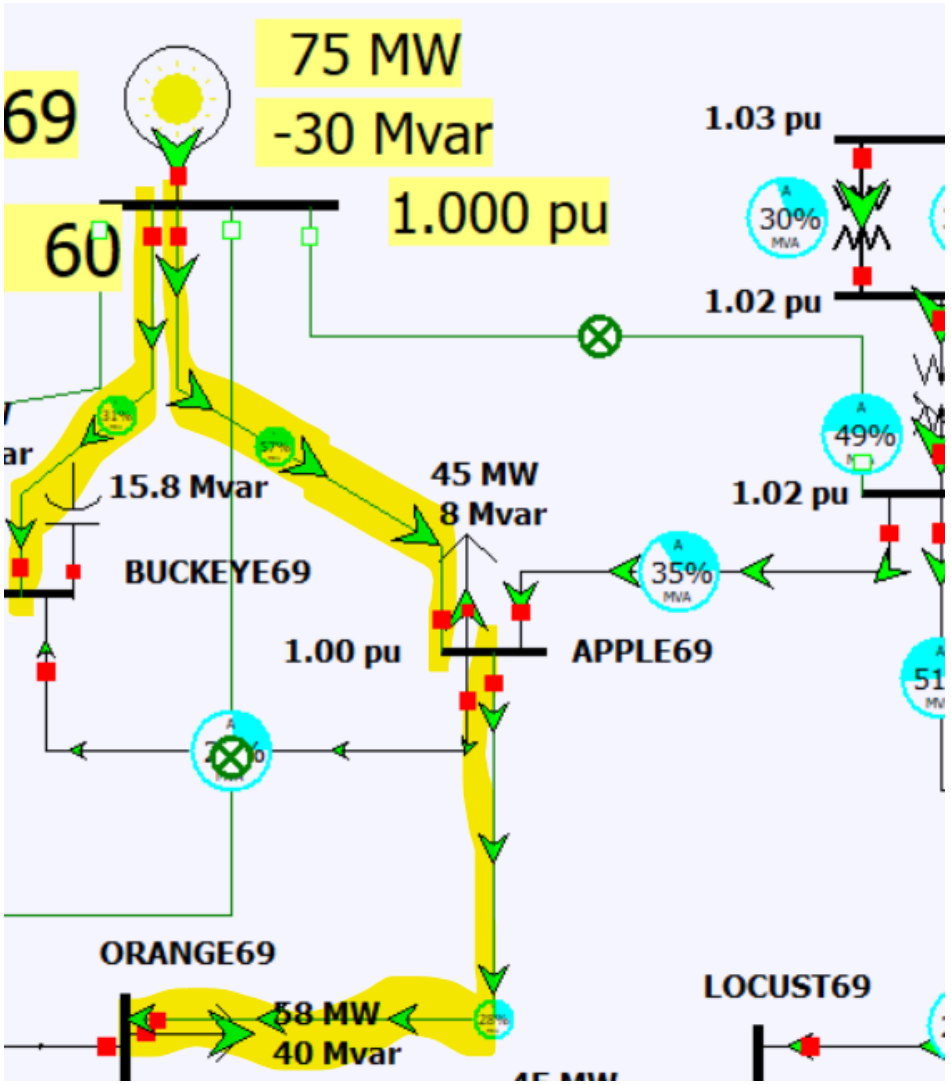
Case number	Destination buses	Total distance (km)	Total Cost (M$)
1	BK69, AP69	12	5.94
2	BK69, OAK69	19	8.53
3	BK69, OAK138	19	14.37
4	AP69, OAK69	19	8.53
5	AP69, OAK138	19	14.37
6	BK69, PIINE69	20	8.90
7	BK69, PINE138	20	14.90
8	AP69, PINE69	20	8.90
9	AP69, PINE138	20	14.90
10	BK69, MP69	21	9.27
11	AP69, MP69	21	9.27
12	OAK69, PINE69	27	11.49
13	OAK69, PINE138	27	18.36
14	OAK138, PINE69	27	18.36
15	OAK138, PINE138	27	18.36
16	OAK69, MP69	28	11.86
17	OAK138, MP69	28	18.89
18	PINE69, MP69	29	12.23
19	PINE138, MP69	29	19.42

Final Solution Design

Component	Cost (M$)
NEWSOLAR-BUCKEYE Line	2.97
NEWSOLAR-APPLE Line	2.97
APPLE-ORANGE Line	4.08
Loss Savings (1.0 MW)	-2.63
Total	**7.39**

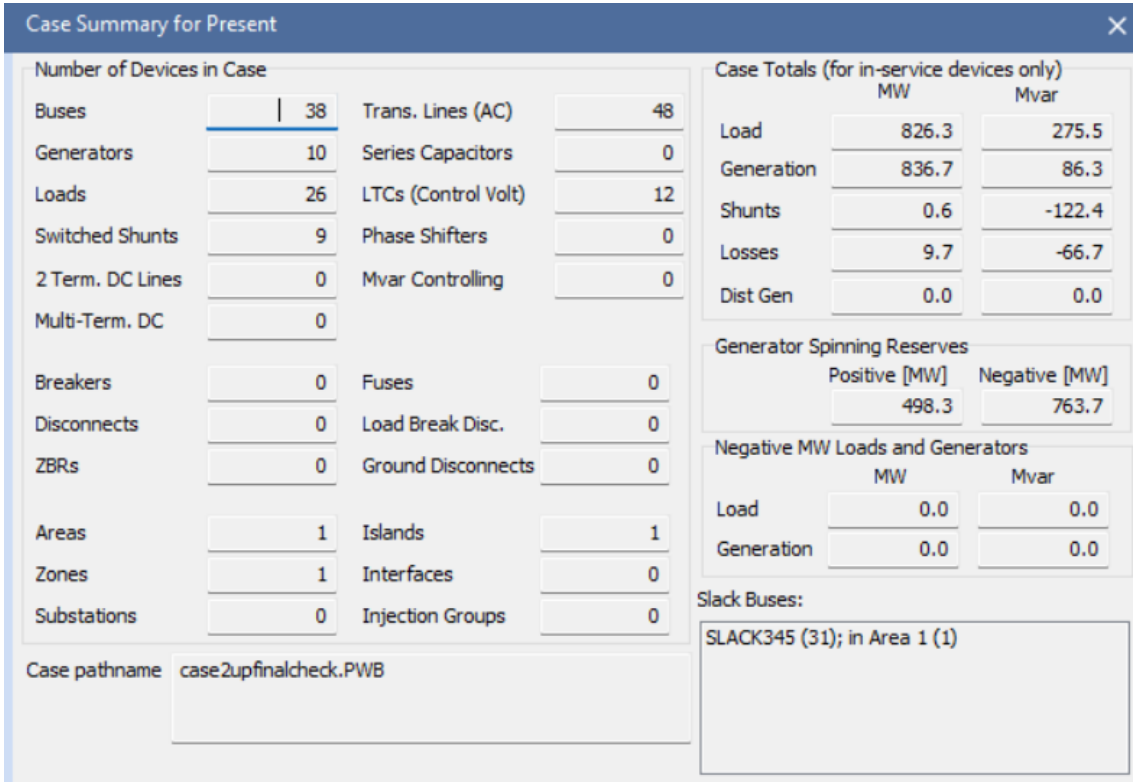
Key Features:

- All new lines use Rook conductor
- Redundant paths to NEWSOLAR
- No existing line upgrades needed



Loss Reduction Analysis

- Base case losses: 10.7 MW
- Final configuration: 9.7 MW
- Savings: 1.0 MW
- 5-year energy savings: 43,800 MWh
- Economic value: \$2.63M at \$60/MWh



Conclusions

- Optimal solution: 69 kV connections to BUCKEYE & APPLE, plus new APPLE-ORANGE line
- Strategic APPLE-ORANGE connection eliminates need for OAK-BUCKEYE upgrade
- Better loss reduction: 1.0 MW vs 0.9 MW in previous solution
- Total cost \$7.39M including loss savings
- Meets all reliability and redundancy requirements with simpler implementation

Questions?

Thank you