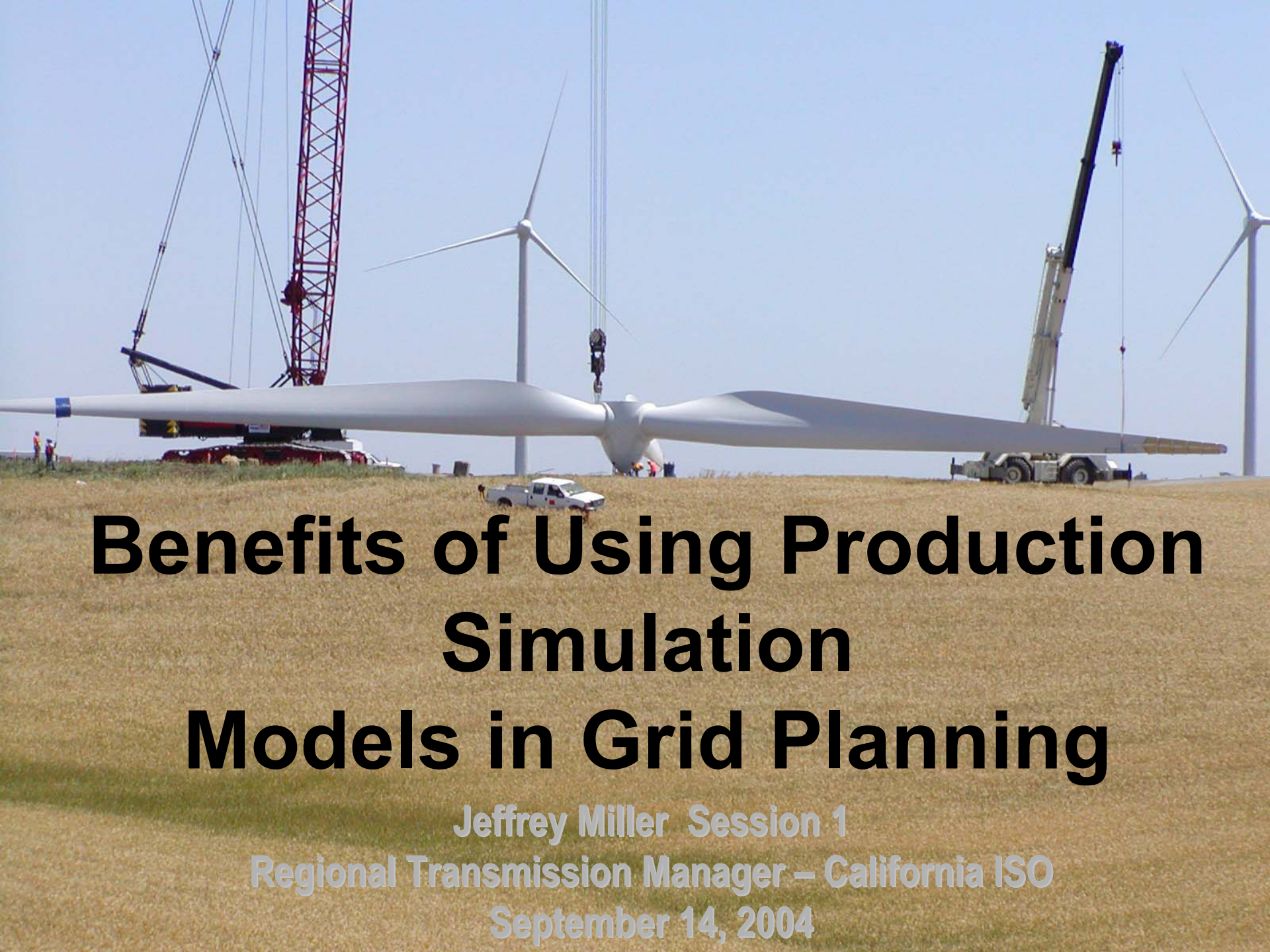


Benefits of Using Production Simulation Models in Grid Planning

Jeffrey Miller Session 1
Regional Transmission Manager – California ISO
September 14, 2004

Market Simulation Tool

- Hourly simulation of western interconnection with the typical objective of minimizing total production cost while respecting generation, transmission and operational constraints.
- Useful for predicting the economic and physical performance of large power networks.
- Tool has many other uses not directly related to Grid Planning (i.e., valuing FTR's, energy trading insights, generation profitability, etc.)

CALIFORNIA ISO

California Independent System Operator

Market Simulation Tool

Generation
- capacity
- costs (fuel, O&M)
- outages
- min. up/down times

Transmission
- network data
- constraints
- outages
- operation rules

Load
- distribution
- hourly variations
- load forecast

Others
- hydro data

User specified scenarios (gas/hydro)

Market Modeling

Market Simulation

Additional Scenarios

Unit Dispatch
- hourly dispatch
- capacity factors
- production cost

Transmission
- **hourly flows**
- **flow duration curves**
- **congested paths/lines**
- **shadow price**

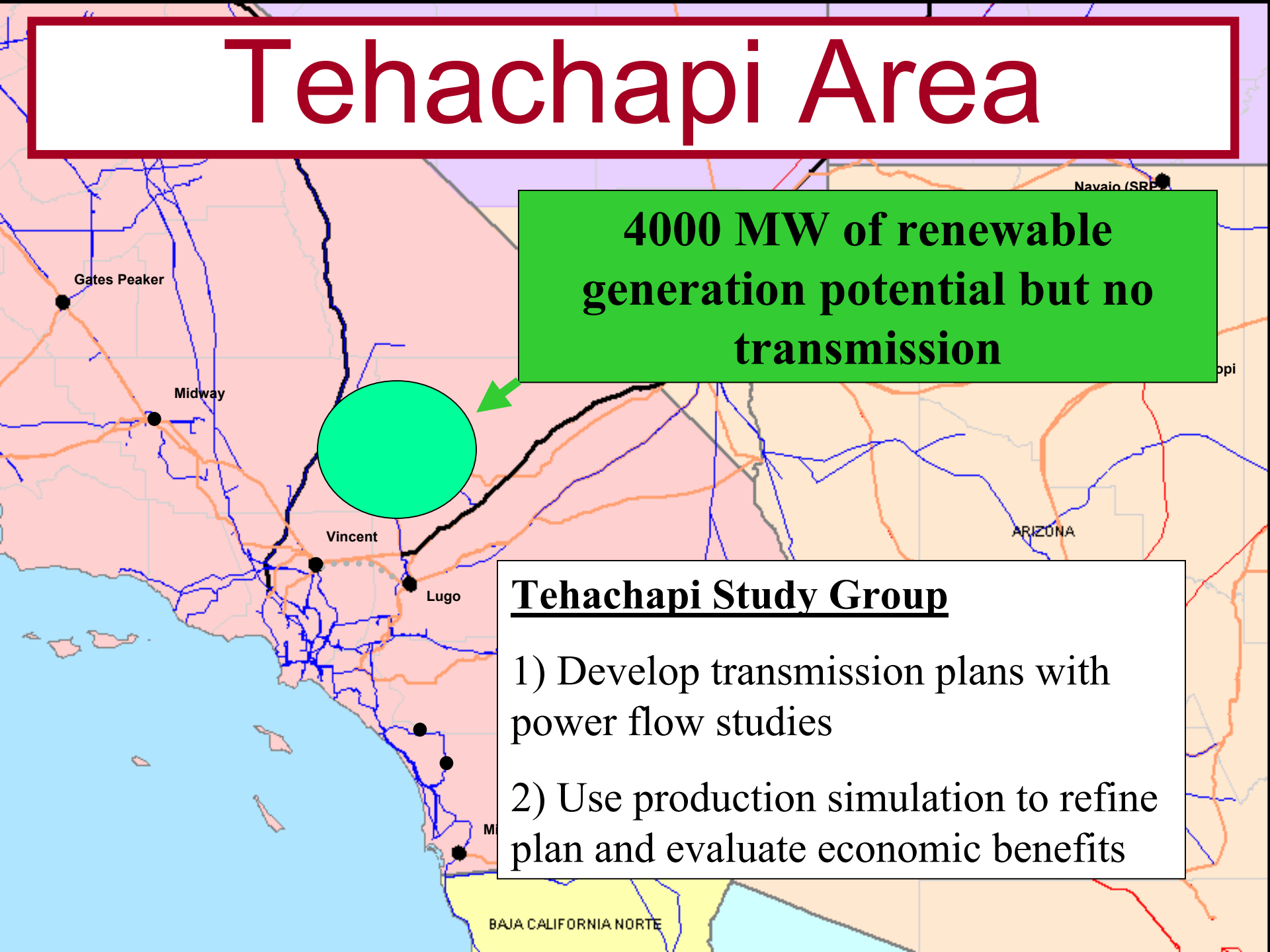
Prices
- LMP for loads
- LMP for generators

Example Benefits of Production Simulation Analysis

- Refining project design
- Technical comparison of project alternatives
- Effect on transmission paths
- Economic comparison of projects
- Effect on existing generation utilization
- Effect on use of natural resources

Tehachapi Example

Tehachapi Area



4000 MW of renewable generation potential but no transmission

<u>Tehachapi Study Group</u>

1) Develop transmission plans with power flow studies

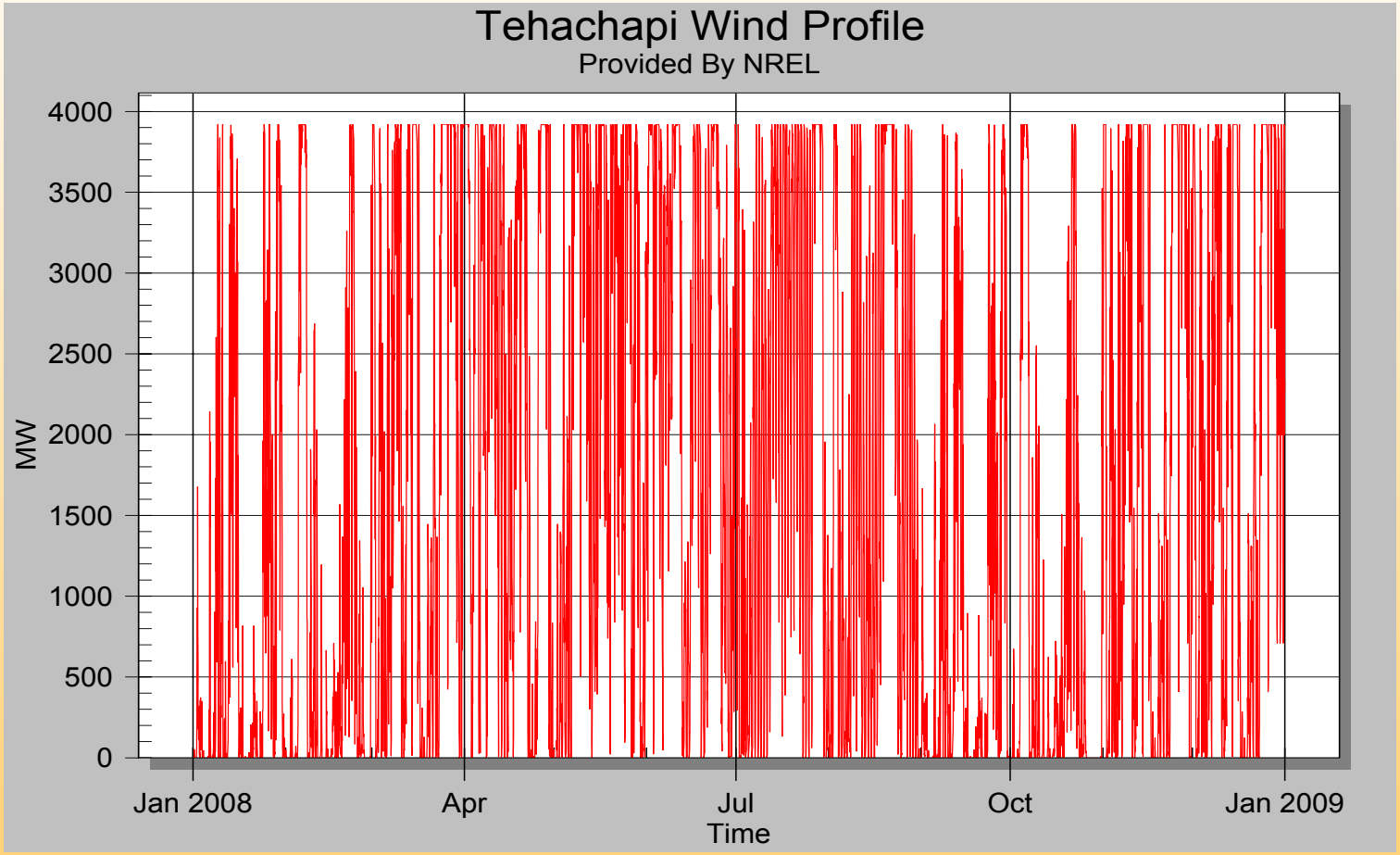
2) Use production simulation to refine plan and evaluate economic benefits

Tehachapi Generation Assumptions

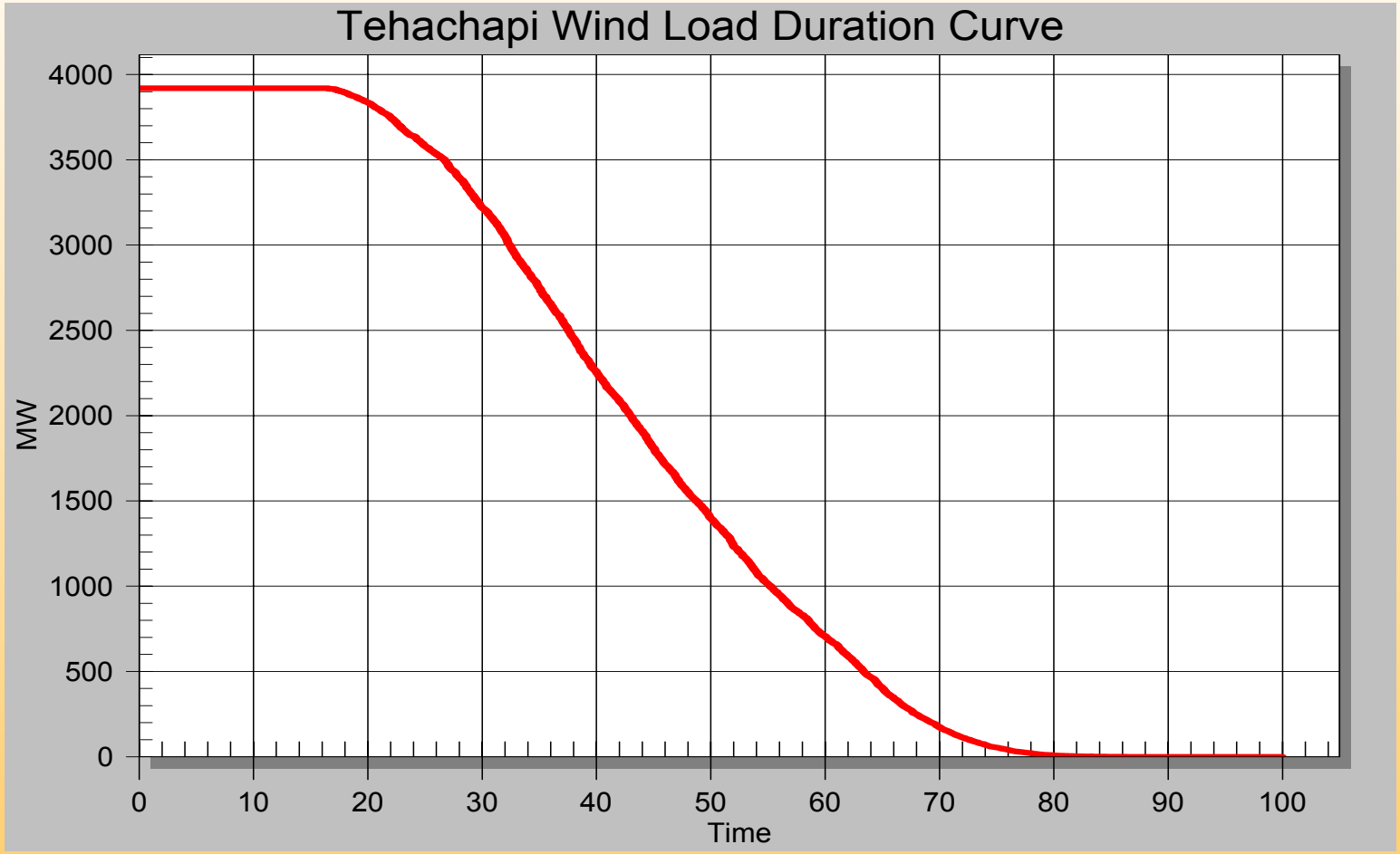
- Production simulation requires hourly dispatch for wind over a year.
- Existing wind unit dispatch is based on historical data.
- New wind unit dispatch was developed by National Renewable Energy Laboratory (NREL) and other stakeholders.
  - Assumed 70 meter rotor, 7.5 m/s speed and 2% unavailability.
  - Resulted in 45% capacity factor.

Tehachapi Hourly Wind Profile

(Developed by NREL and Other Stakeholders)

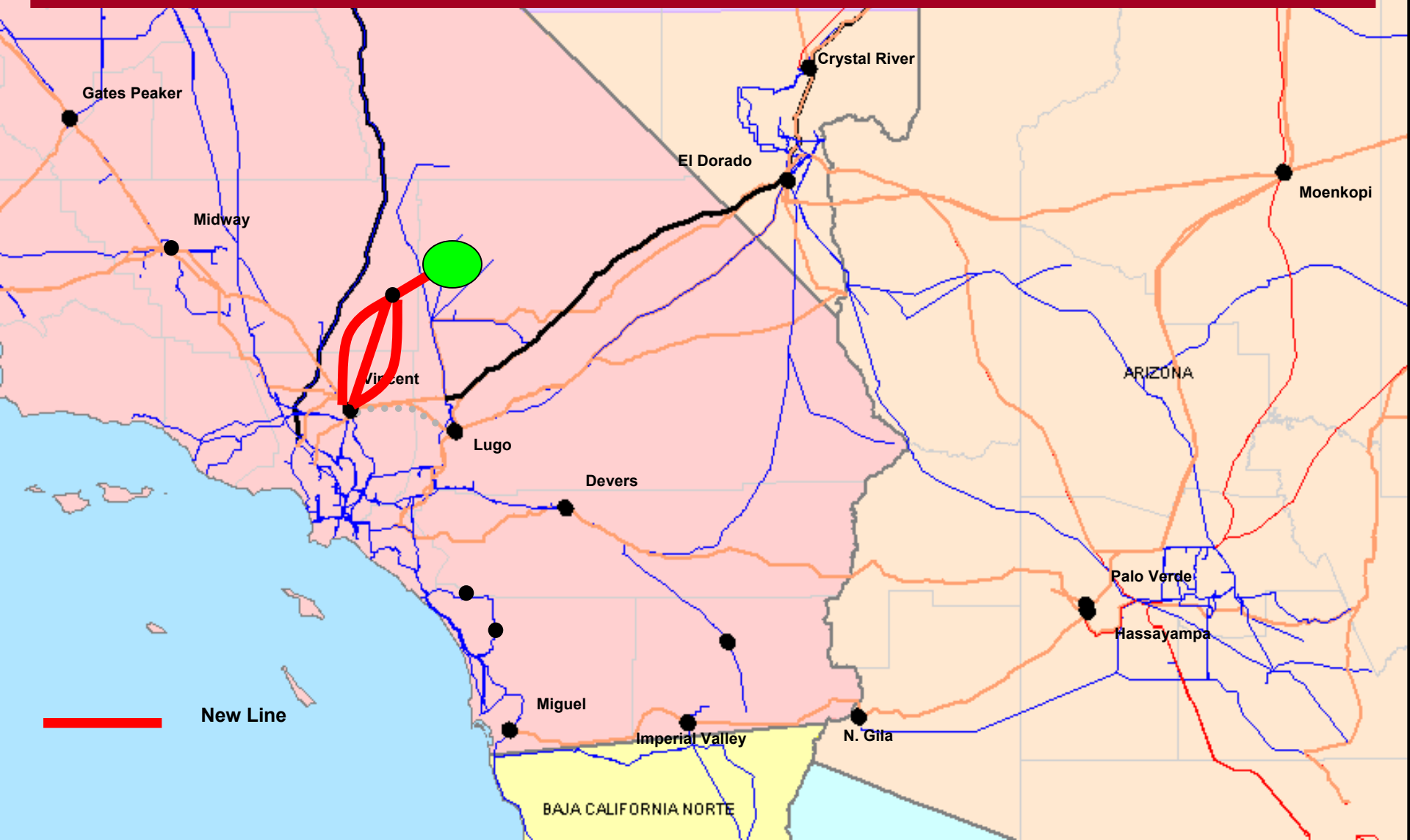


Tehachapi Wind Duration Curve



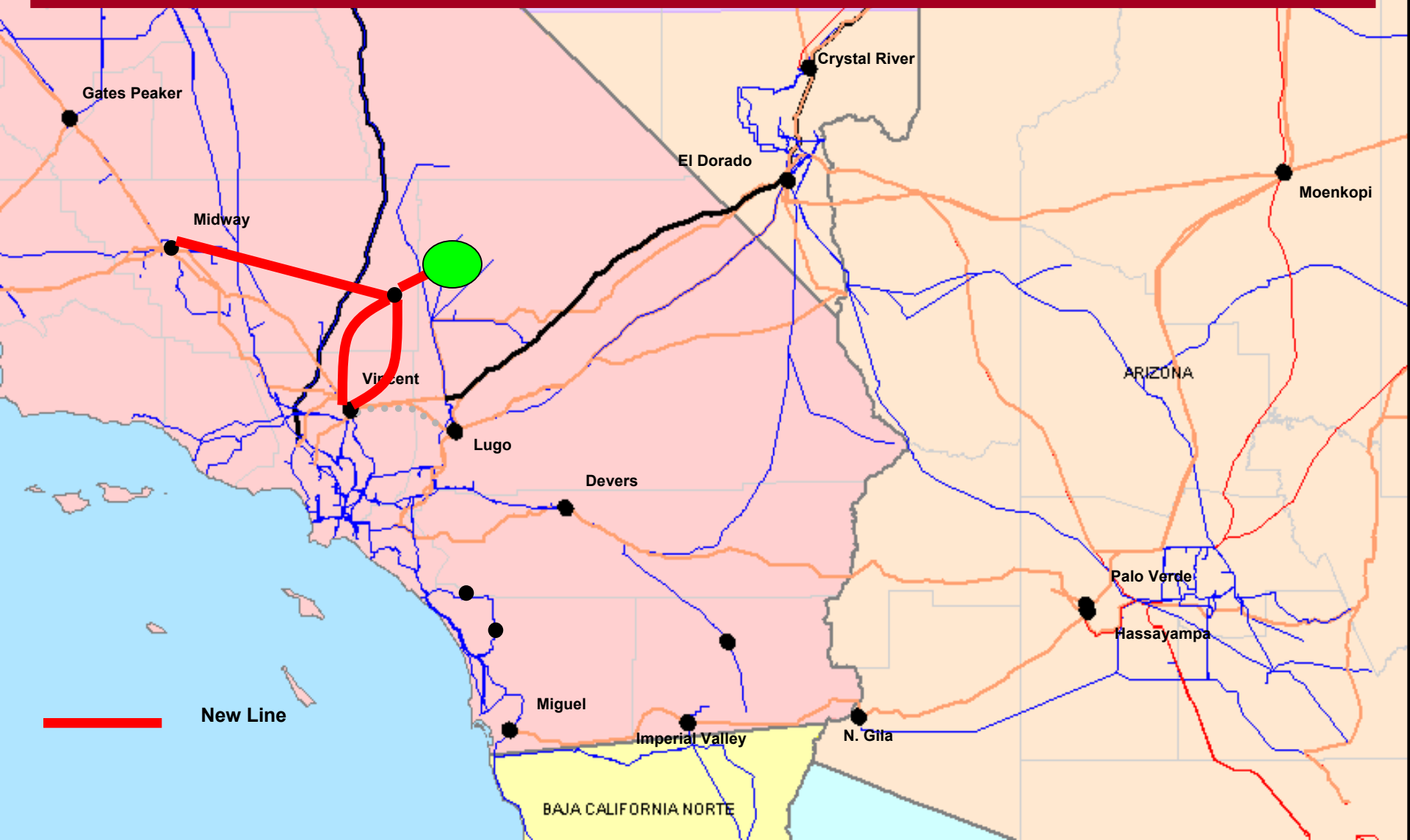
Alternative 1 – Vincent Connection

Tehachapi Transmission Plan



Alternative 2 – Midway Connection

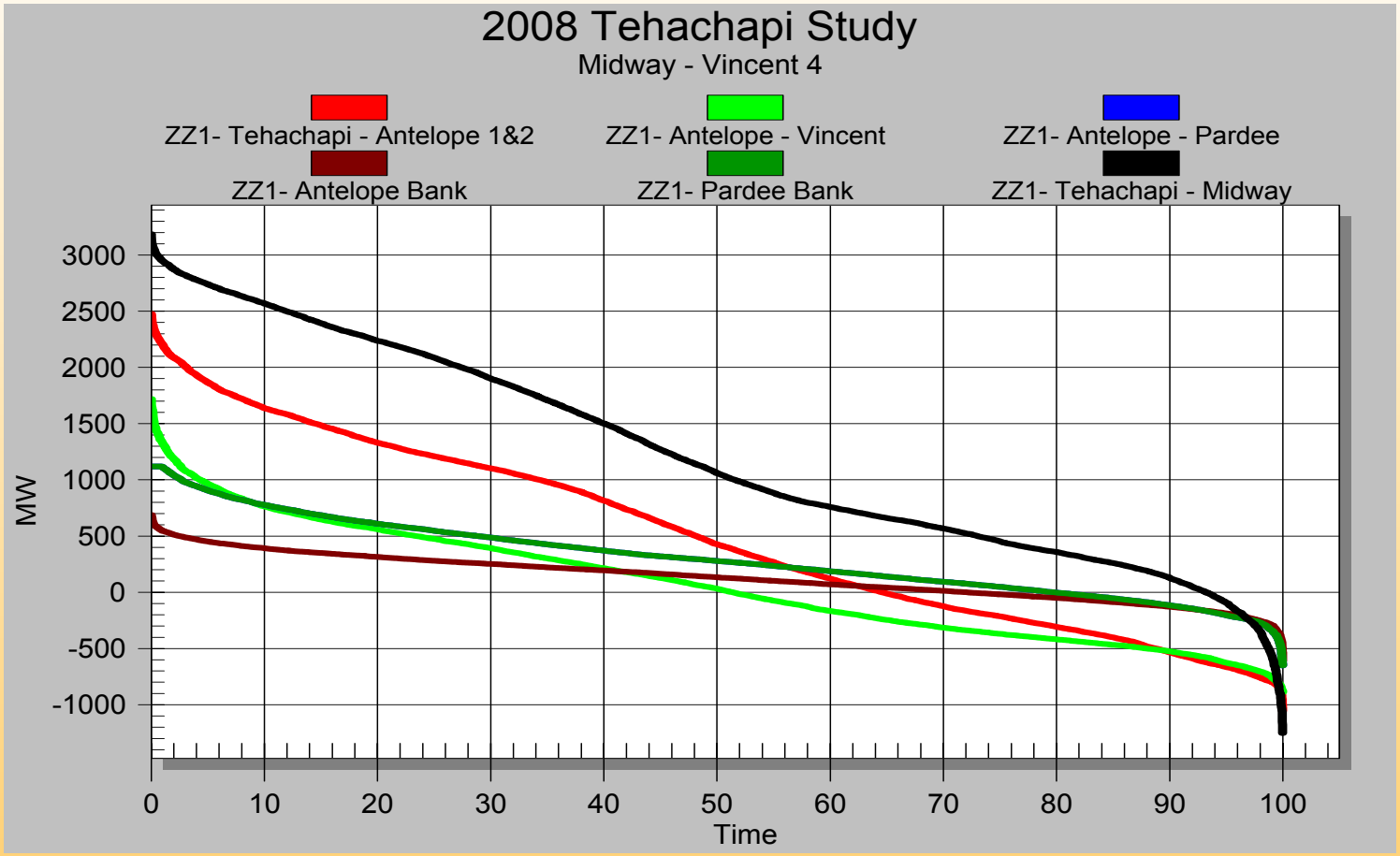
Tehachapi Transmission Plan



Example - Project Refinement

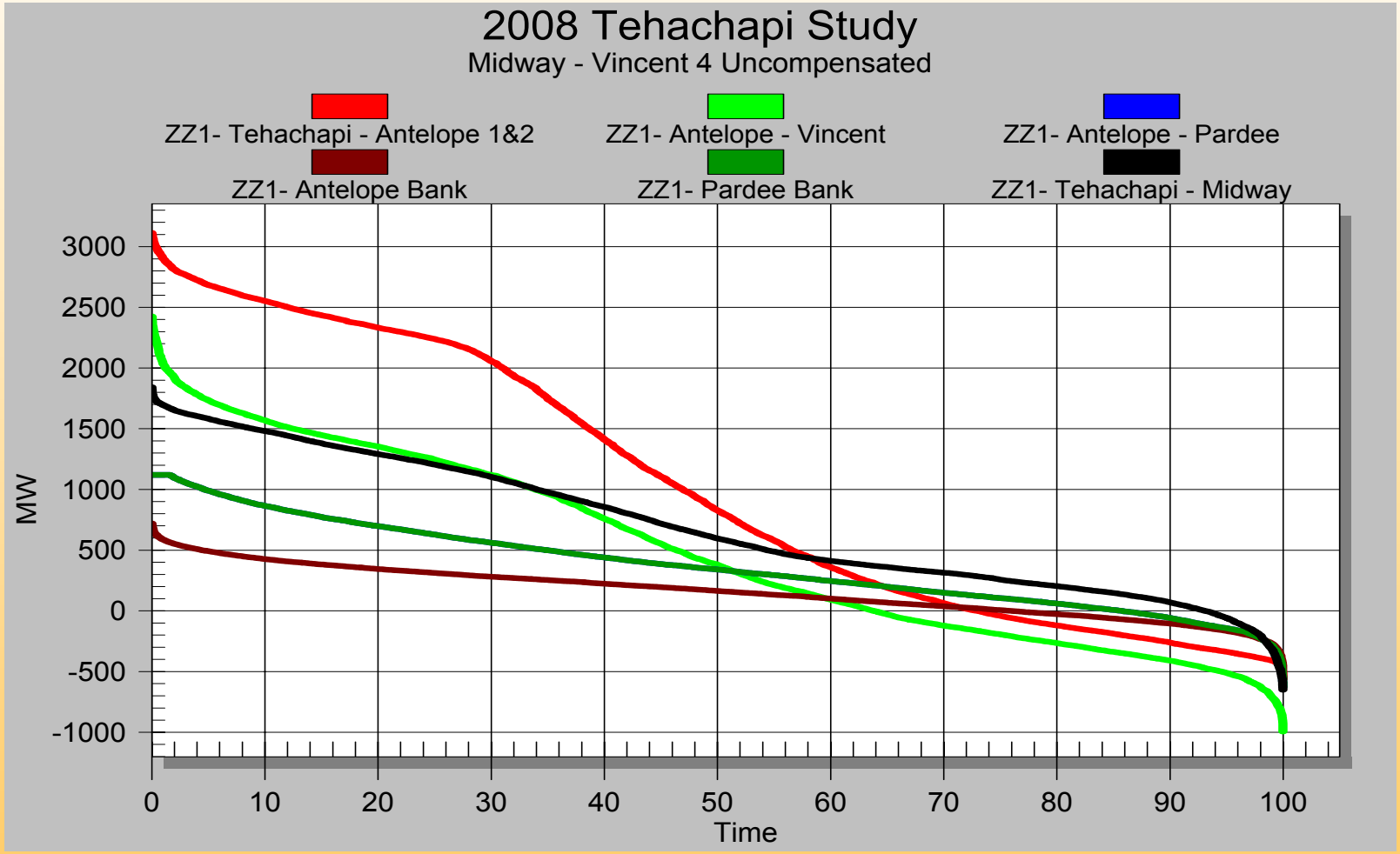
- Series compensation in the Tehachapi-Midway line

Alternative 2: Midway Connection



Alternative 2: Midway Connection

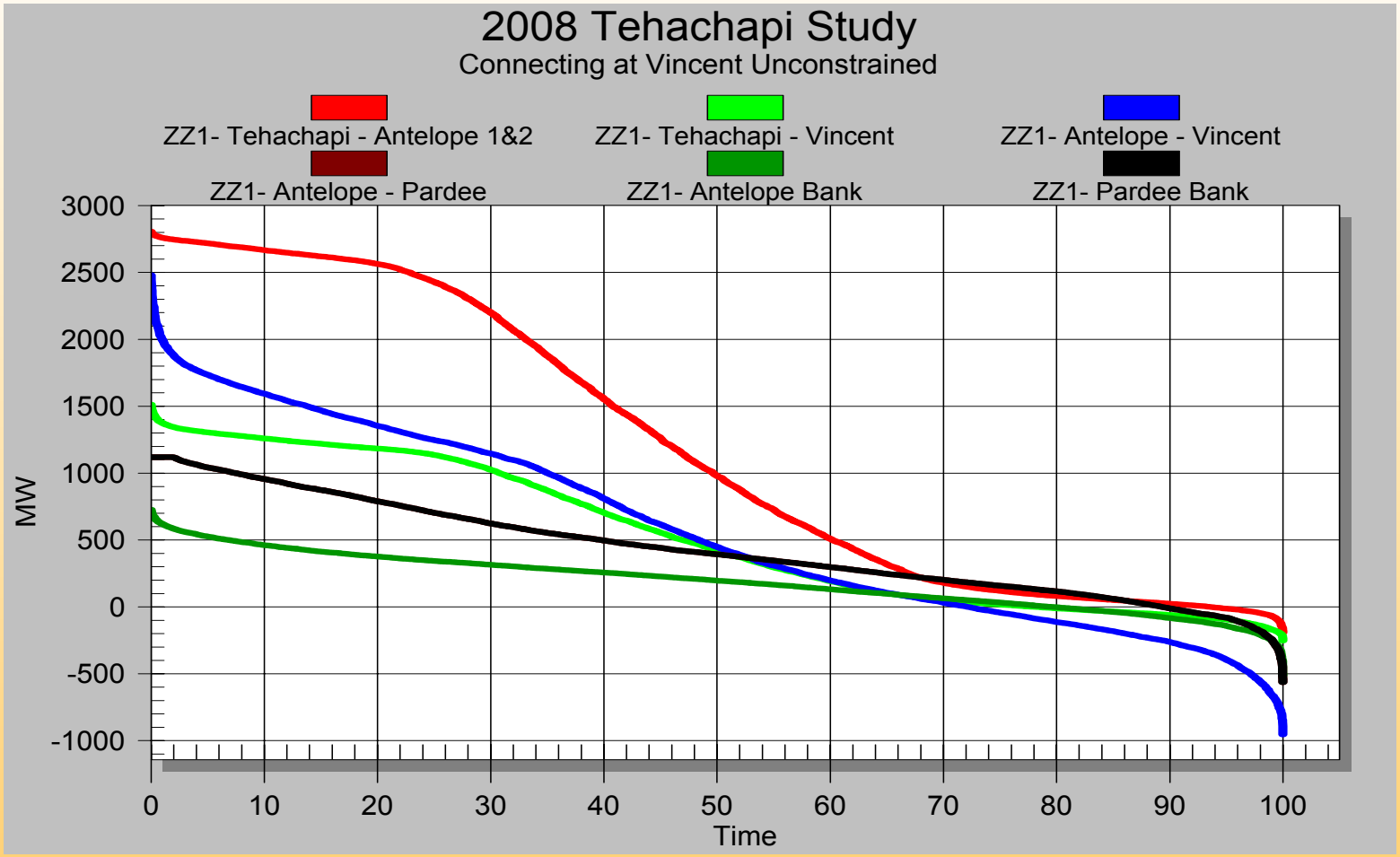
Without Tehachapi – Midway Compensation



Example - Technical Comparison

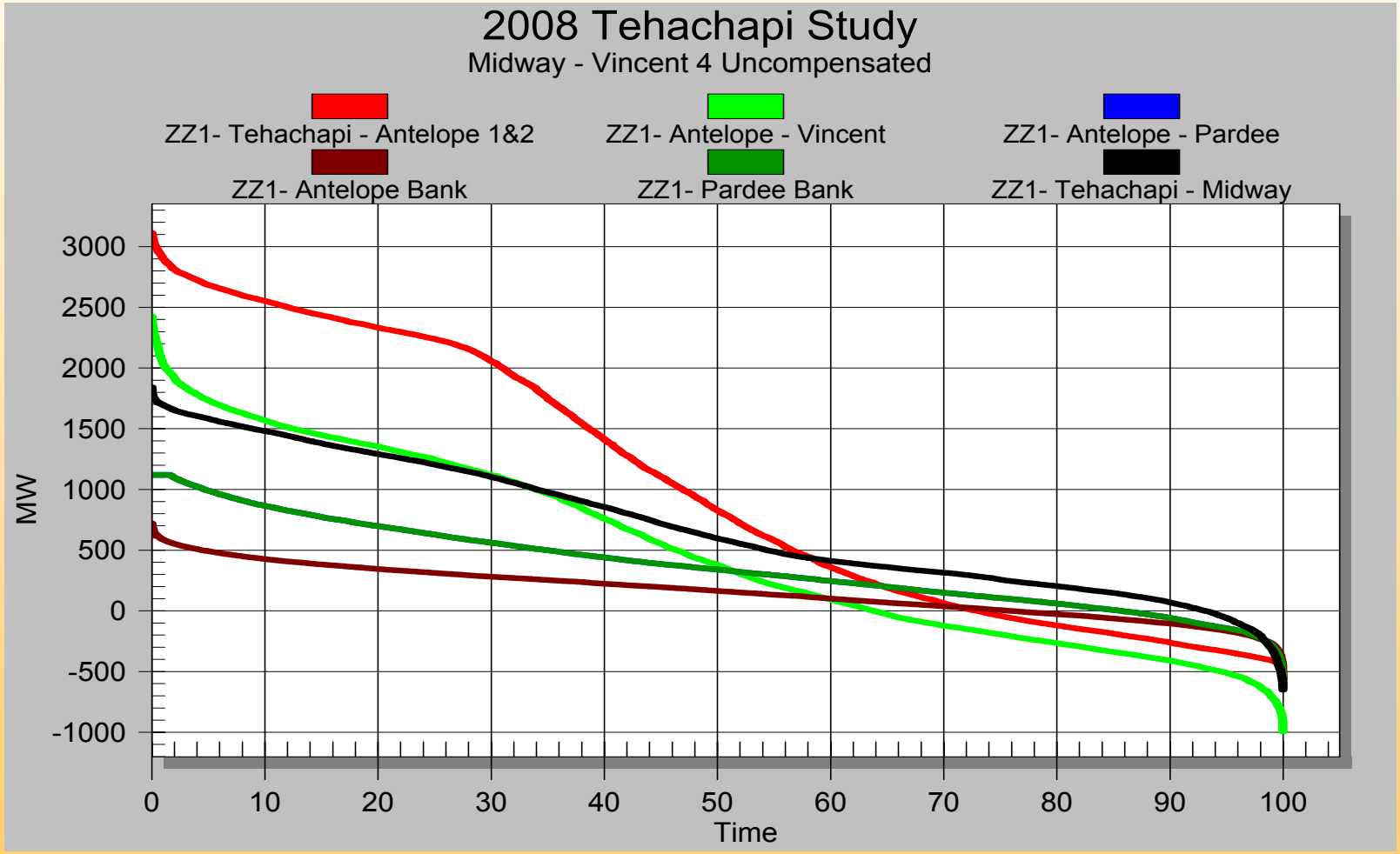
- Midway Connection versus Vincent connection

Alternative 1: Vincent Connection



Alternative 2: Midway Connection

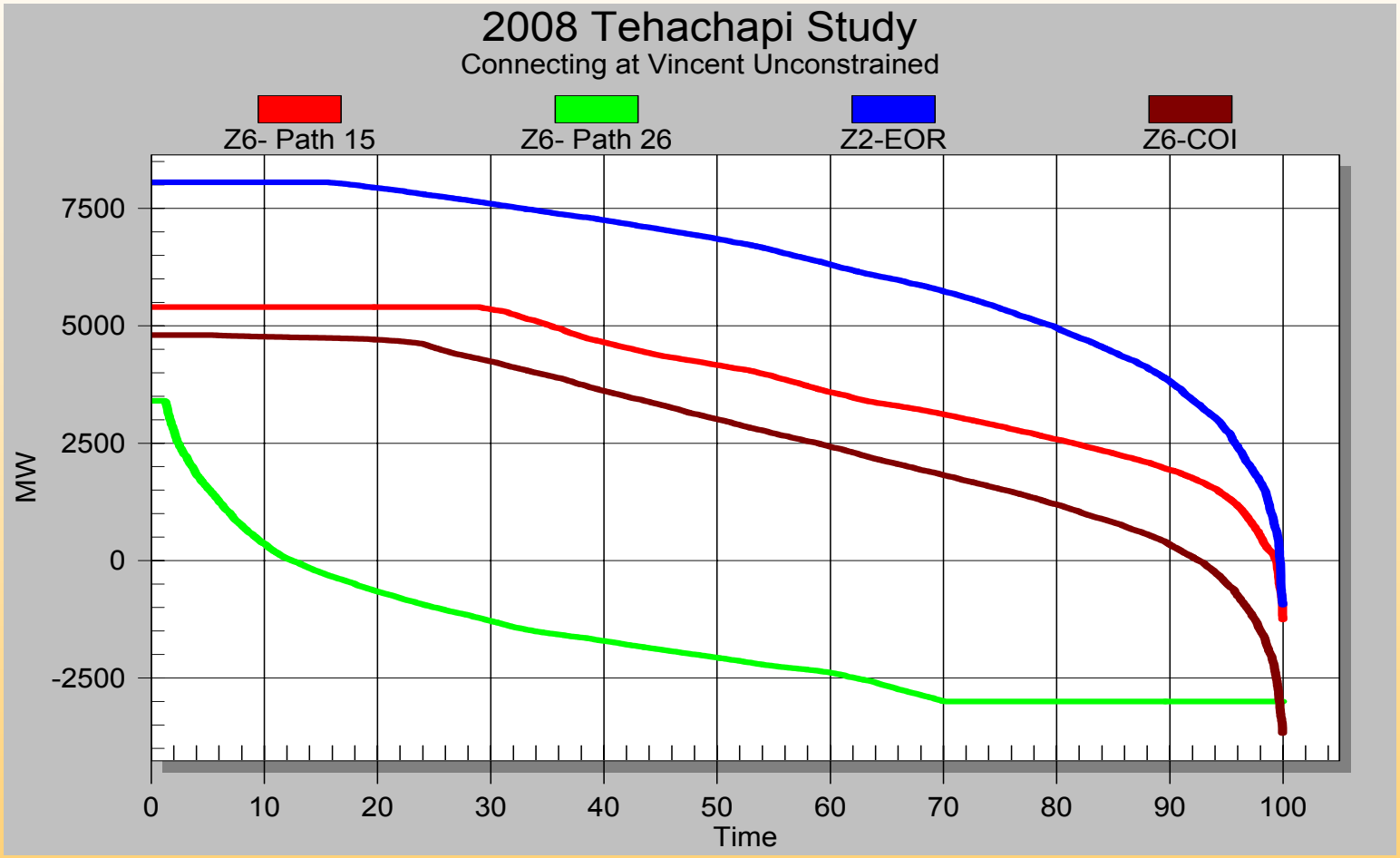
Without Tehachapi – Midway Compensation



Example - Effect on Transmission Paths

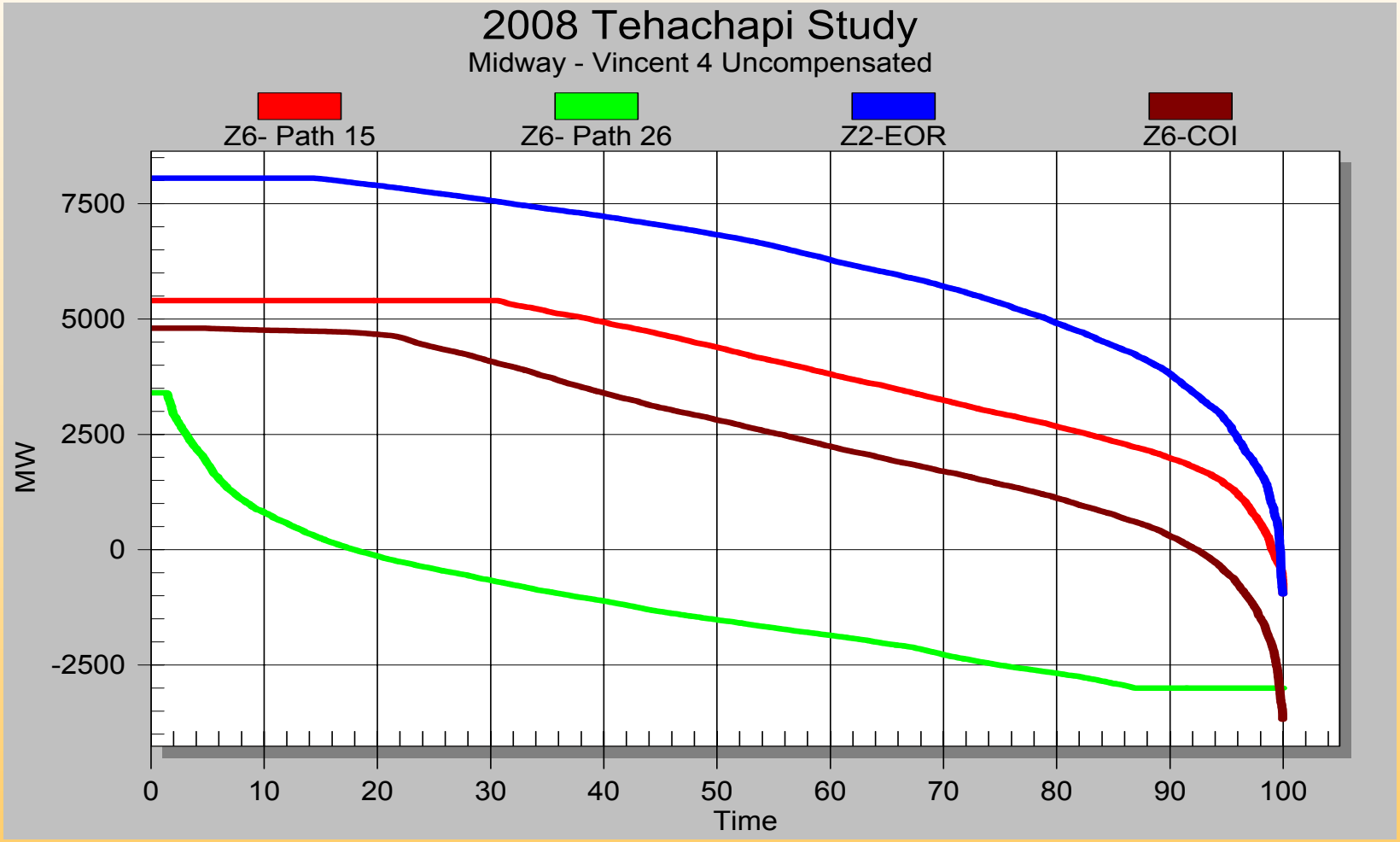
- Path 26 – Midway-Vincent
  - Between Central California and Southern California
- Path 15 – Los Banos-Gates
  - Between northern California and central California

Alternative 1: Vincent Connection



Alternative 2: Midway Connection

Without Tehachapi – Midway Compensation



Example - Economic Comparison

- What are the changes in power costs to ISO Ratepayers for the Midway connection versus the Vincent connection?

ISO Ratepayers Benefits (2008 $)

Due to New Wind Generation and Transmission Plan

	Midway - Antelope -Vincent	Vincent Option
Change in Consumer Surplus	$248,744.00	$249,816.00
Change in Producer Surplus	-$105,232.27	-$117,494.16
Change in Congestion Rent	-$10,525.75	-$10,489.57
Total Benefits	$132,985.97	$121,832.27

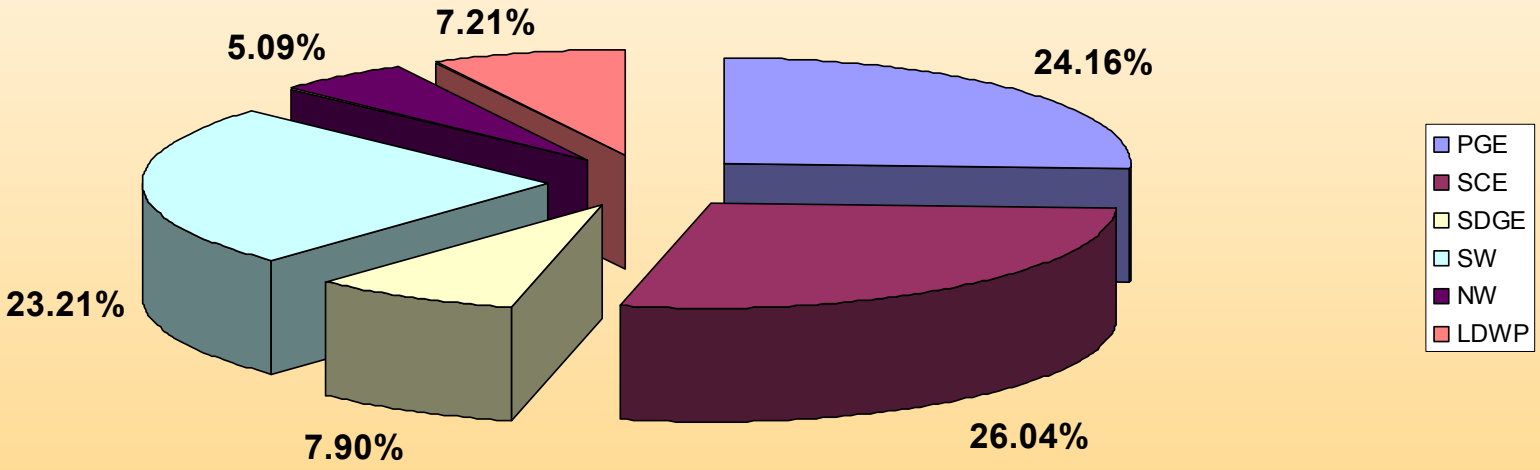
All numbers in k$

Example - Effect on Existing Generation Utilization

- What generation is redispatched to accommodate the 4000 MW of Tehachapi wind generation?

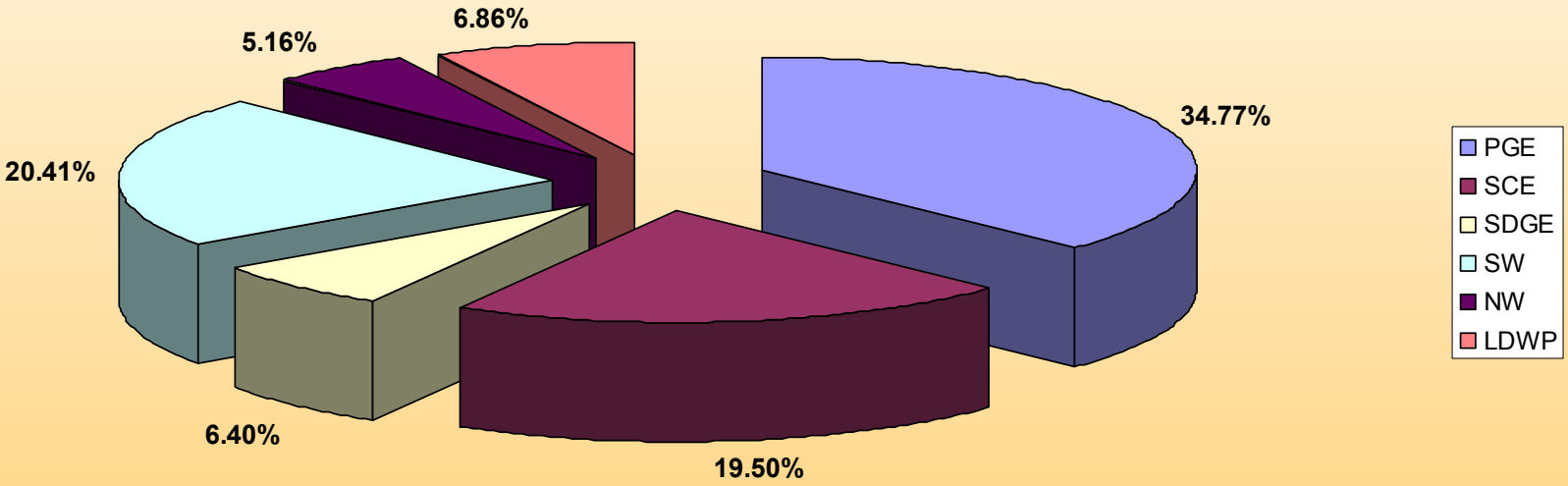
Alternative 1: Vincent Connection

Wind Energy Flow



Alternative 2: Midway Connection

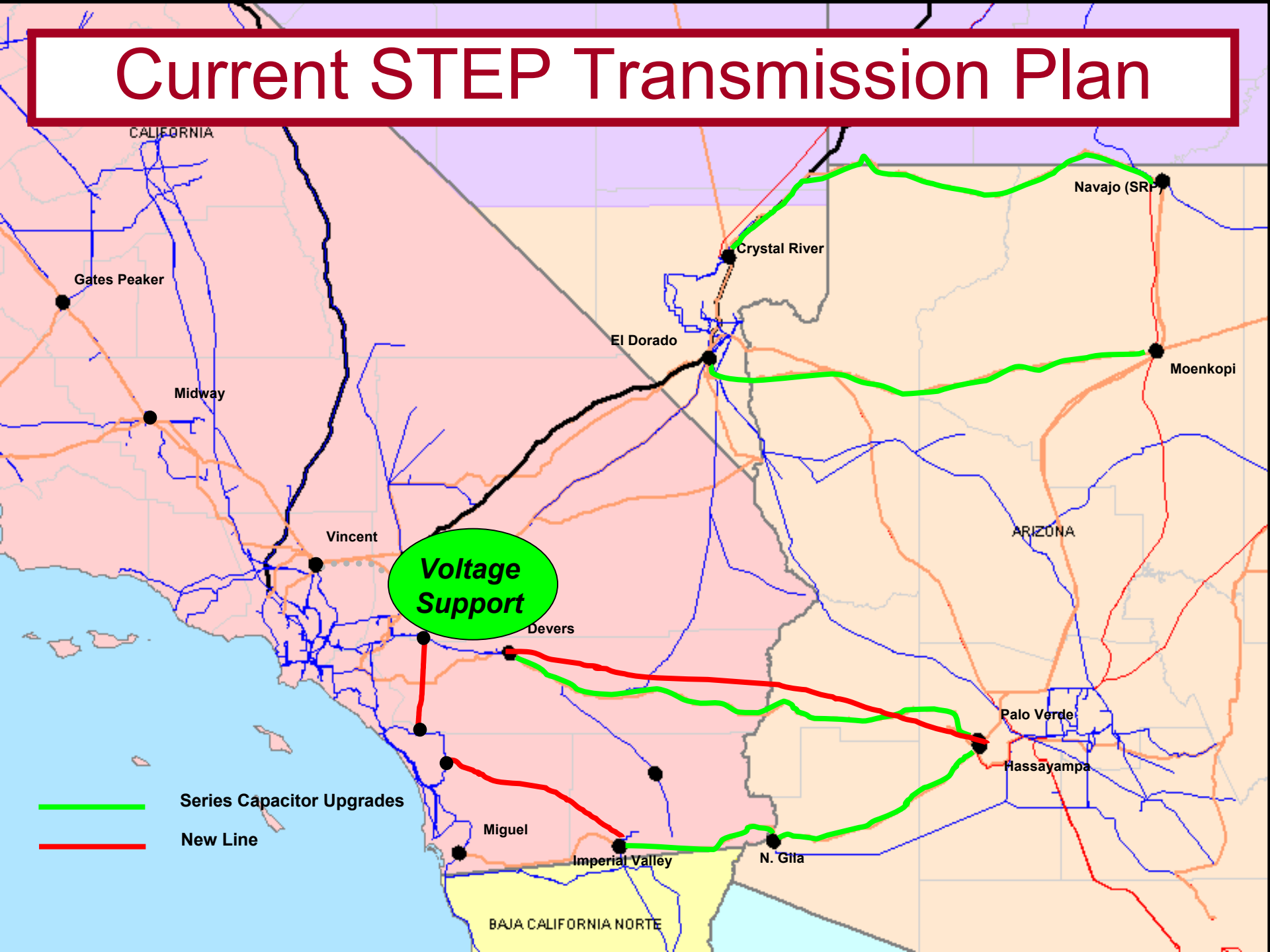
Without Enforcing Path 26 Limit
Wind Energy Flow



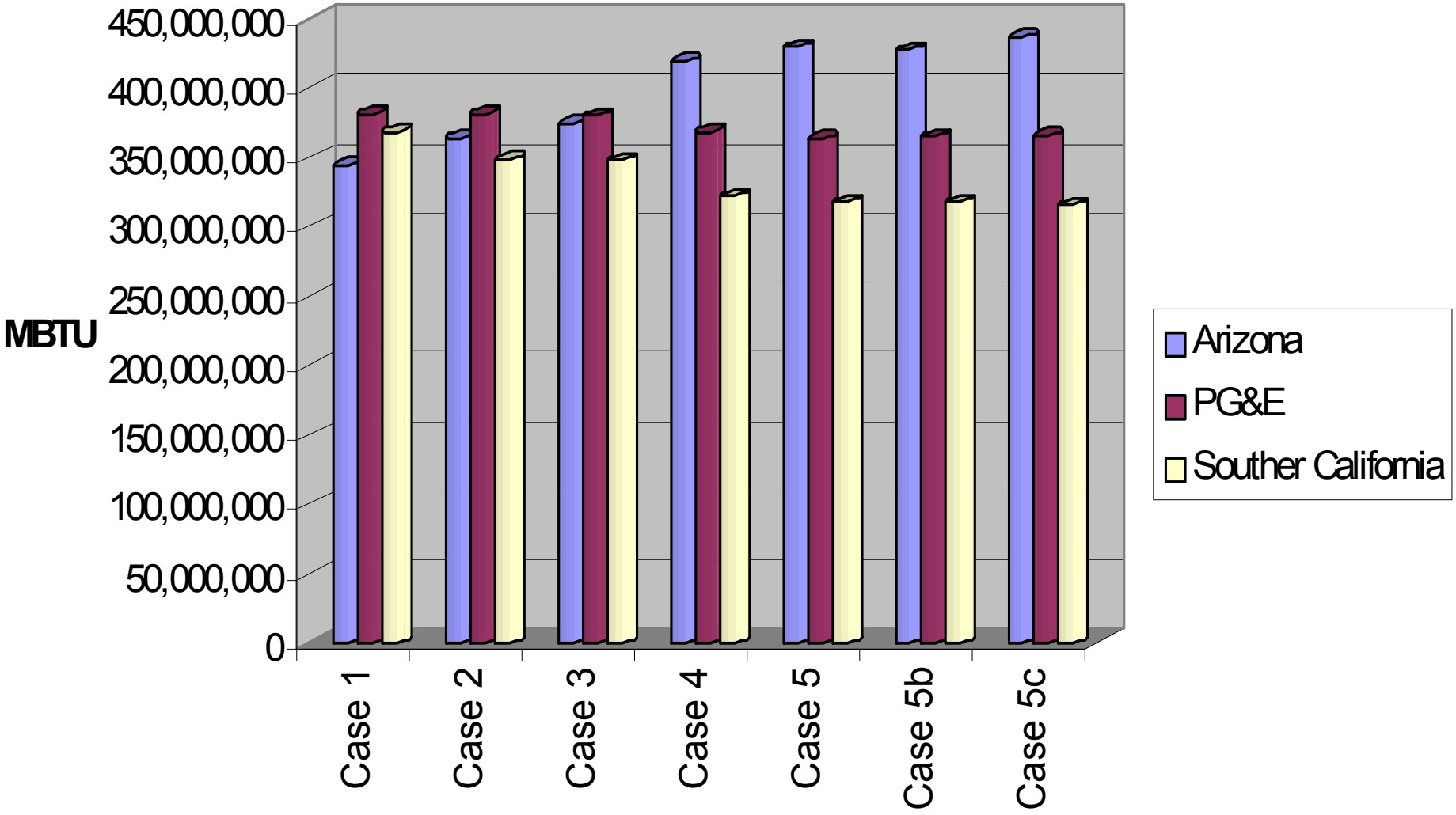
Example - Effect on Use of Natural Resources

- What is the impact of a transmission addition on natural gas consumption?

Current STEP Transmission Plan



Gas Consumption



Questions?