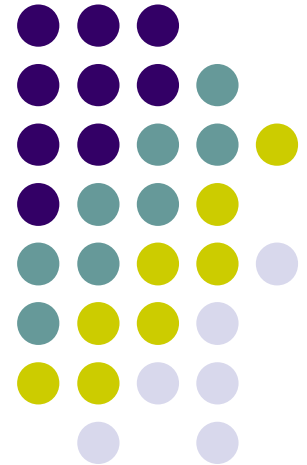
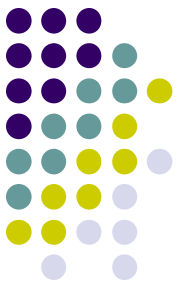


Transmission Line Siting: Analyzing Transmission Demand + Siting Difficulty

Shalini Vajjhala
CEIC Seminar
4 March 2003

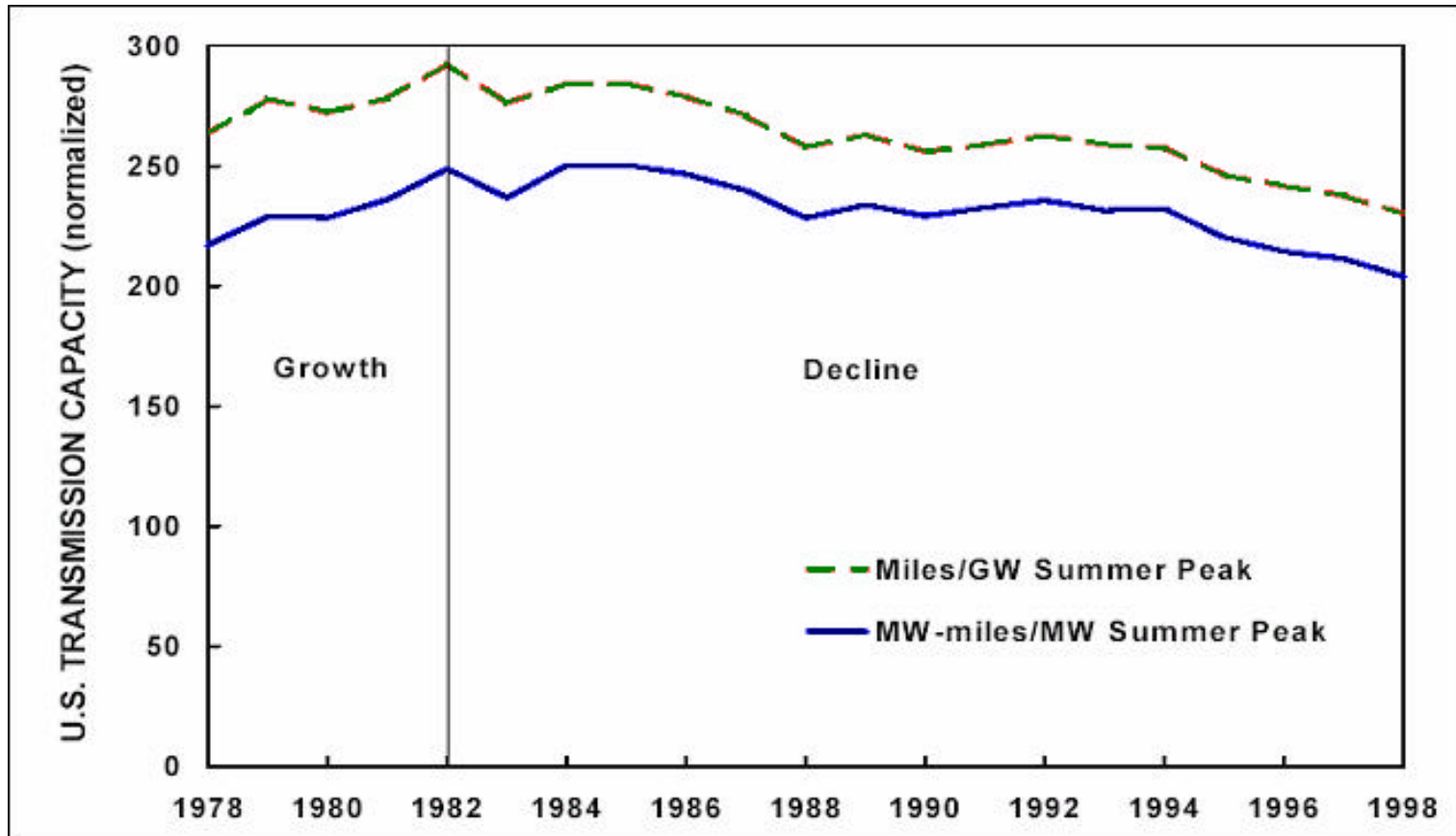
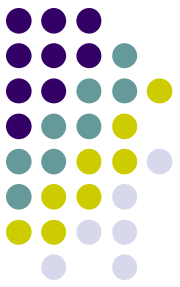




The Transmission Picture

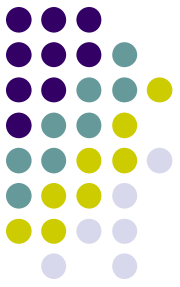
- Characterizing transmission issues
 - Need for new transmission capacity
 - Obstacles to transmission construction
 - Lack of quantitative siting data
- Quantifying siting problems
 - Indicators of transmission demand + siting difficulty
 - Analyses of state demand and difficulty
- Identifying siting constraints
- Coordinating policy solutions

Characterizing Transmission Issues

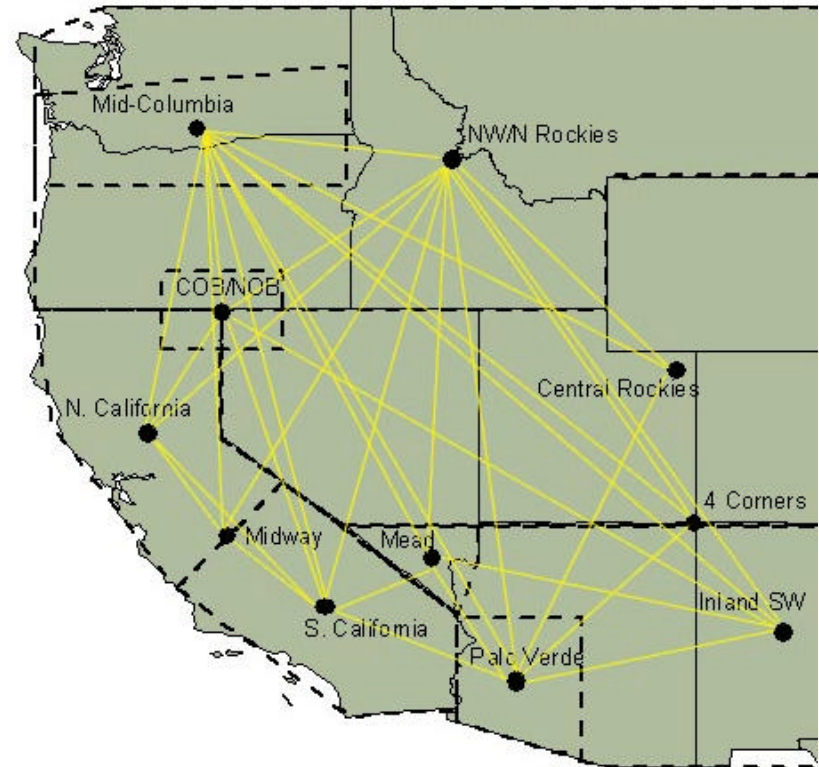


Source: "Transmission Planning for a Restructuring U.S. Electric Industry" (Hirst and Kirby , 2001).

The Demand for Transmission

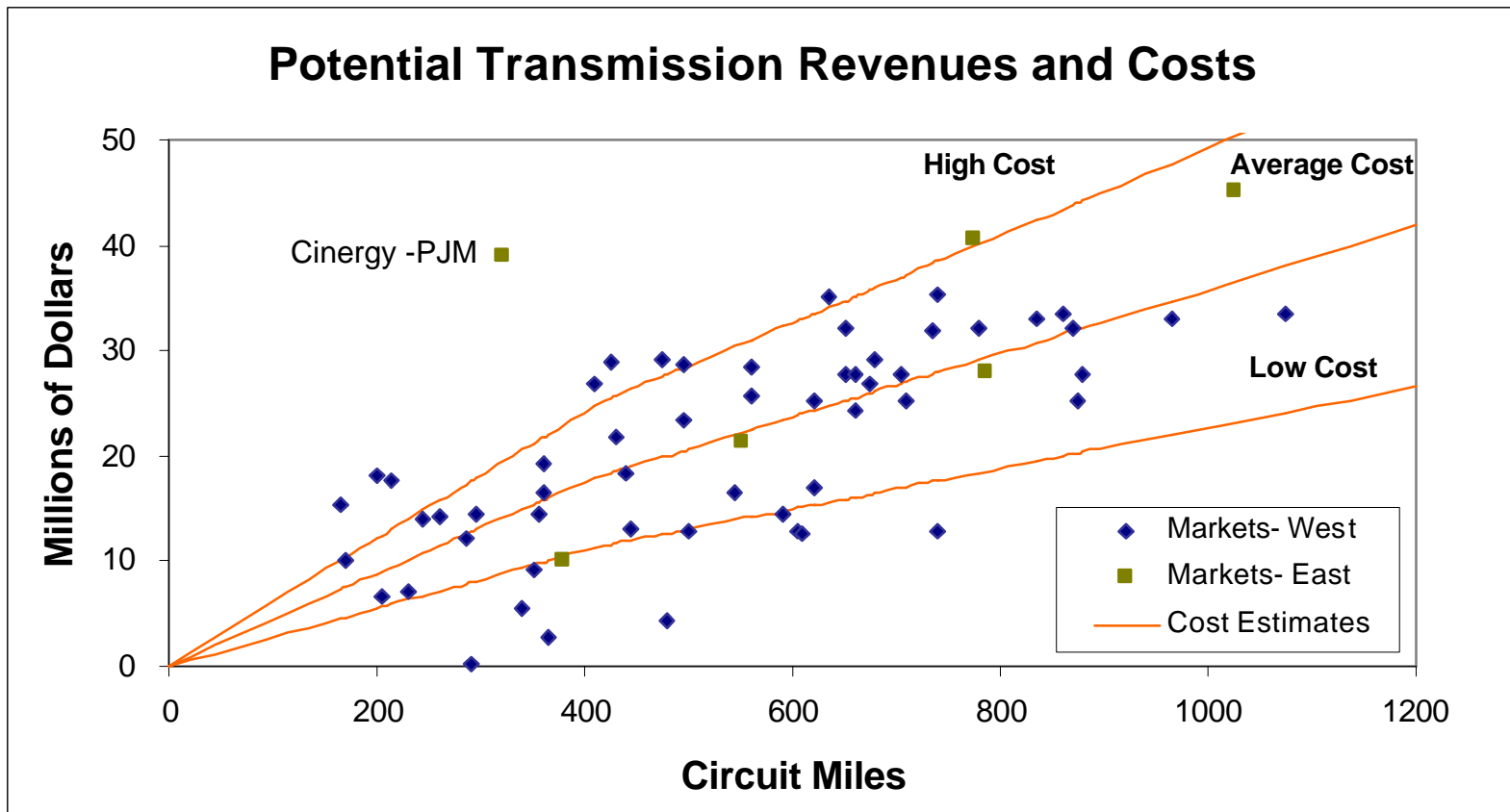
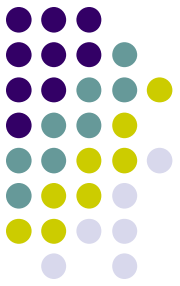


- Is there any economic incentive to build new transmission capacity?
- Analysis of potential transmission profits and costs
- Evaluation of price differential between 61 pairs of markets



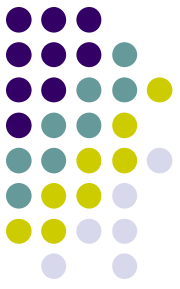
Source: Mapped from EMR regional market definitions

Economic Incentive



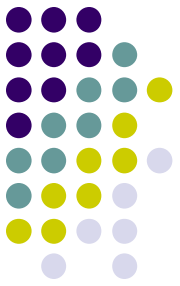
Source Data: Energy Market Reports daily pre-scheduled price publications, Economic Insight Inc. 2000.

Siting Difficulty

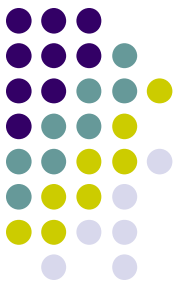


- How difficult is the siting process?
 - Quantifying and comparing siting difficulty
- What factors contribute to siting difficulty?
 - Identifying siting constraints
- What can be done to make siting easier?
 - Implications for new siting policy and regulation

Quantifying Siting Difficulty



- Four unique indicators of transmission demand and siting difficulty
 - Economic
 - Geographic
 - Physical
 - Subjective
- Analysis at the state-level
- Examples for Texas and California



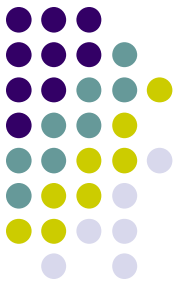
Measure 1: Economic

- Variations in the cost of electricity production
 - Analysis by state
 - Analysis by size of plant
- Example: Baseload cost distribution (\$/MWhr)

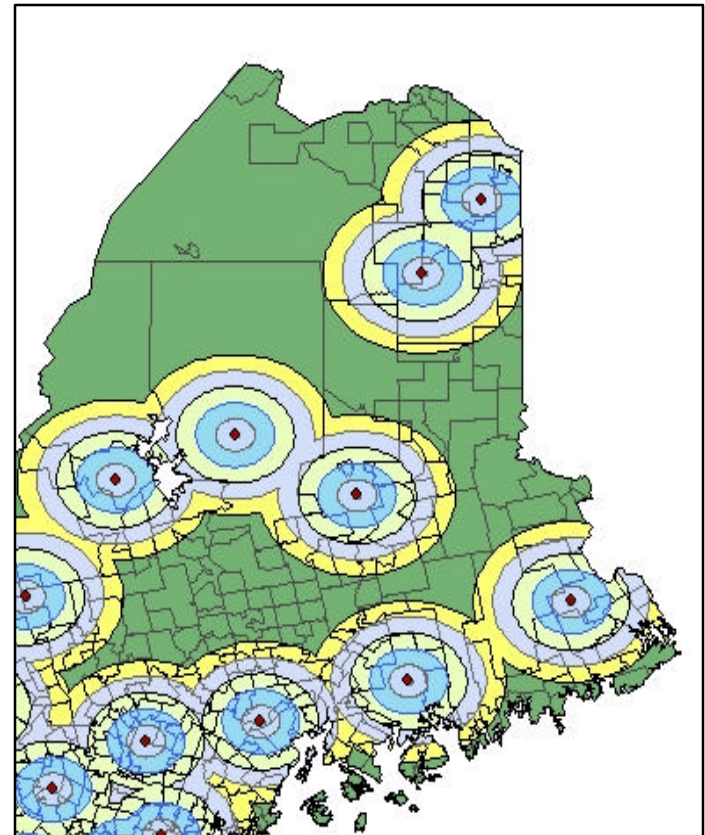
State	Mean	Difference (Max-Min)	Standard Deviation	Potential Peak Savings
Texas	\$23	\$33	\$7	\$32 million
California	\$23	\$68	\$12	\$59 million

Source Data: UDI and RDI/Platts (2000) Generation Plant Cost of Production Databases.

Measure 2: Geographic

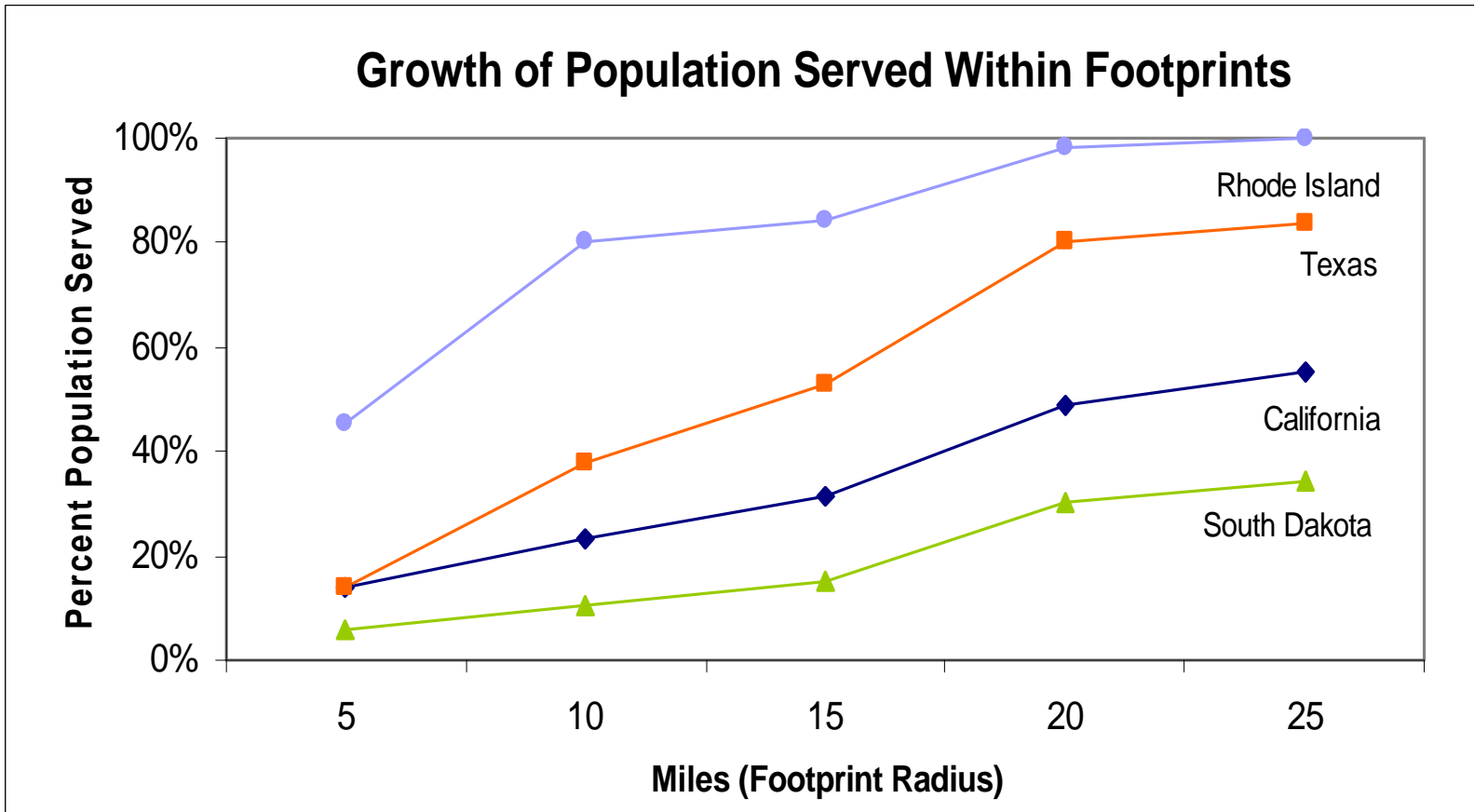
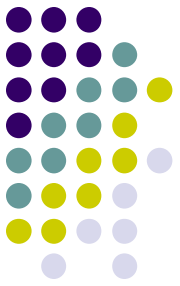


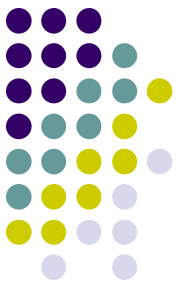
- Co-location of generation capacity and population
- GIS model of generation plants and population distribution by zip-code
- 5-mile increment radii plotted around each plant
- Total population served within each footprint radius calculated by state



Source Data: EPA E-Grid and Census 2000.

Co-location of Capacity + Demand

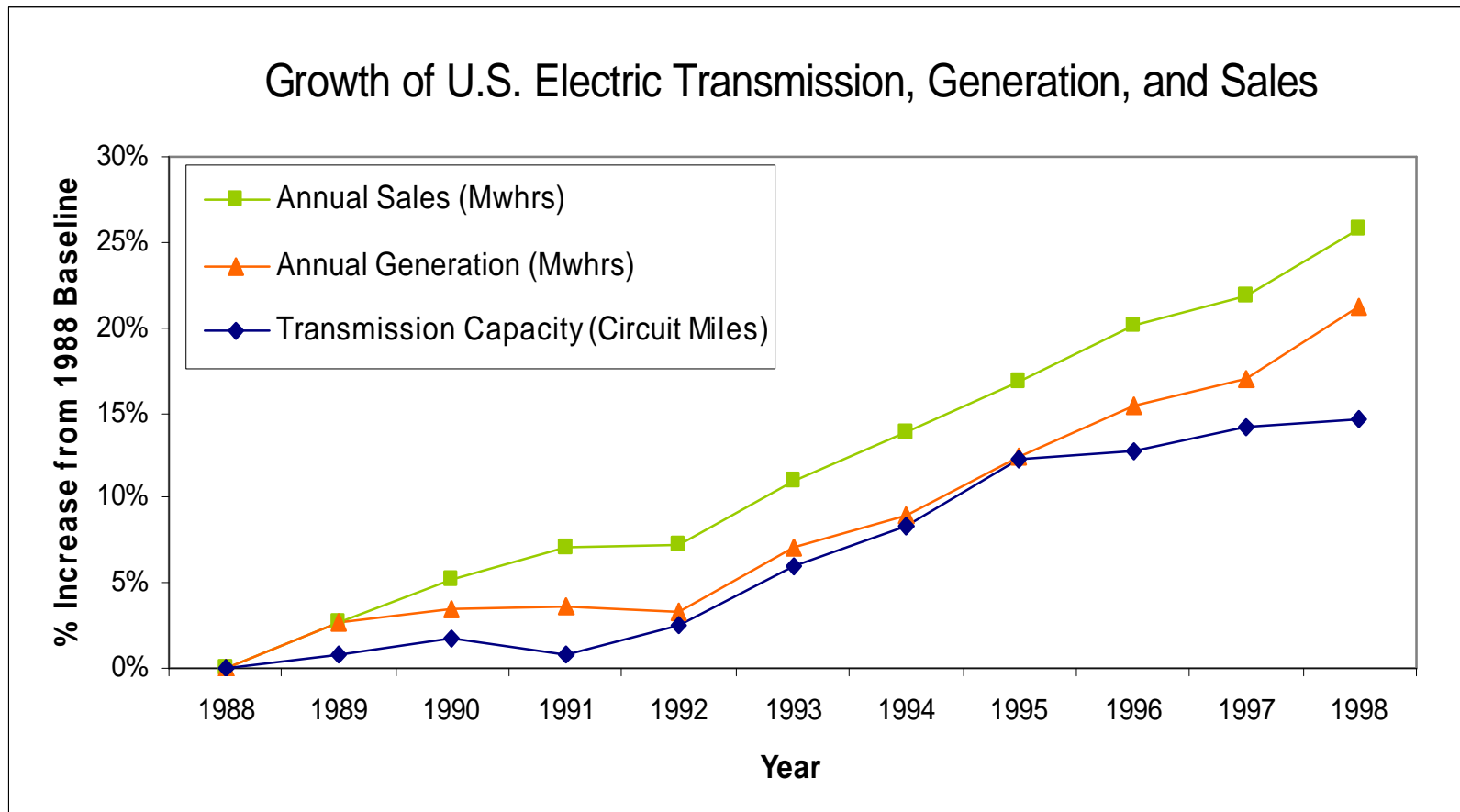
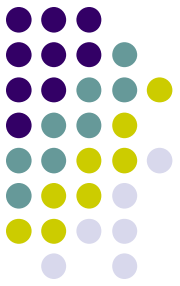




Measure 3: Physical

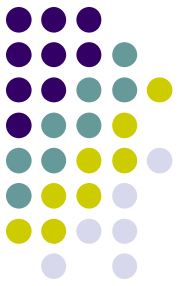
- Ideal indicator- difference between annual proposed and actual miles of construction
- Limited data availability and accuracy
- Growth of transmission capacity relative to:
 - Generation capacity (MW)
 - Net annual generation (MWhrs)
 - Net annual sales/consumption (MWhrs)

Relative Transmission Growth

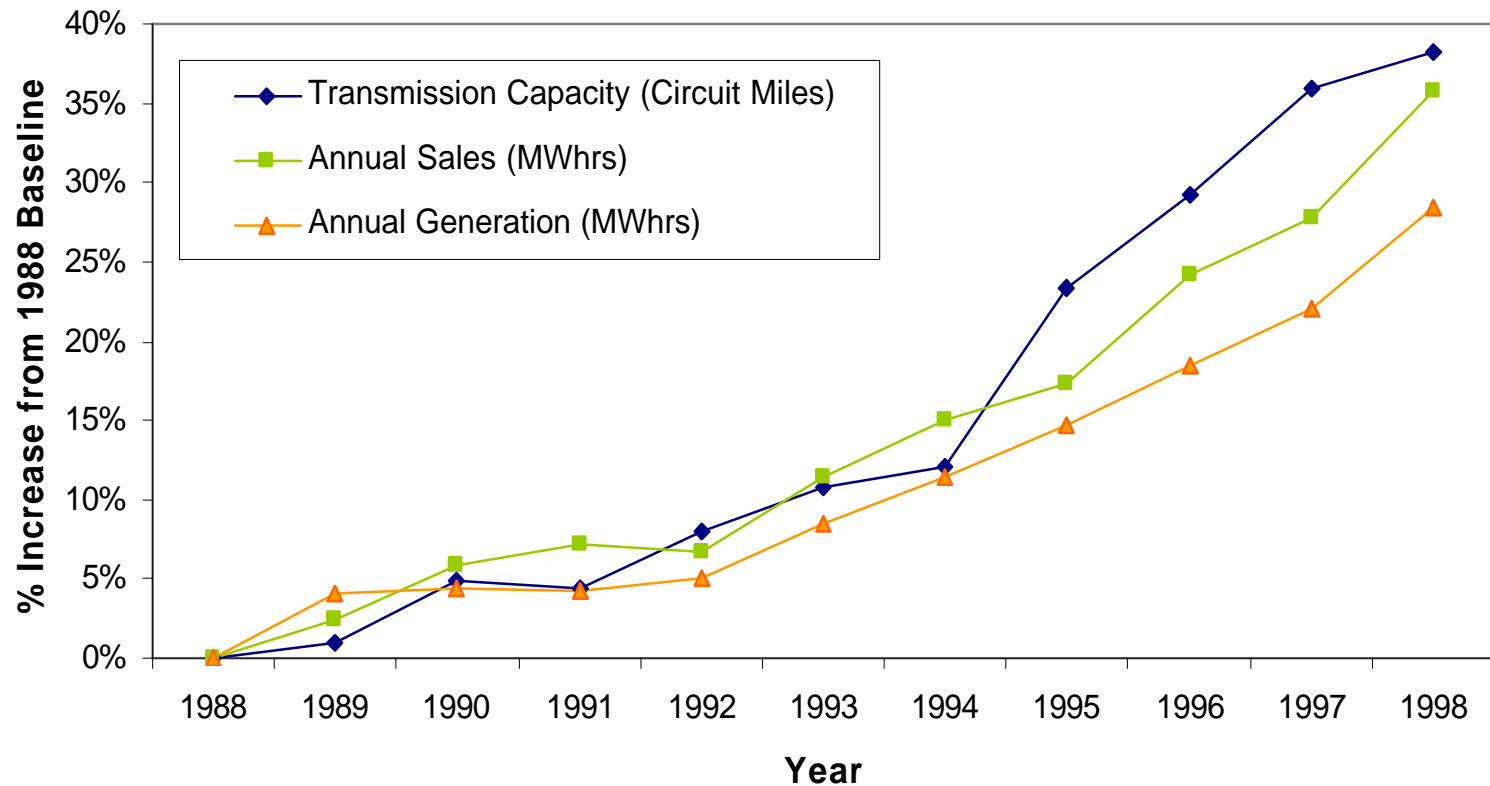


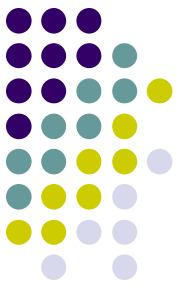
Source Data: DOE and EIA State Electricity Profiles Historic Databases 1988-1998.

Measure 3: Texas



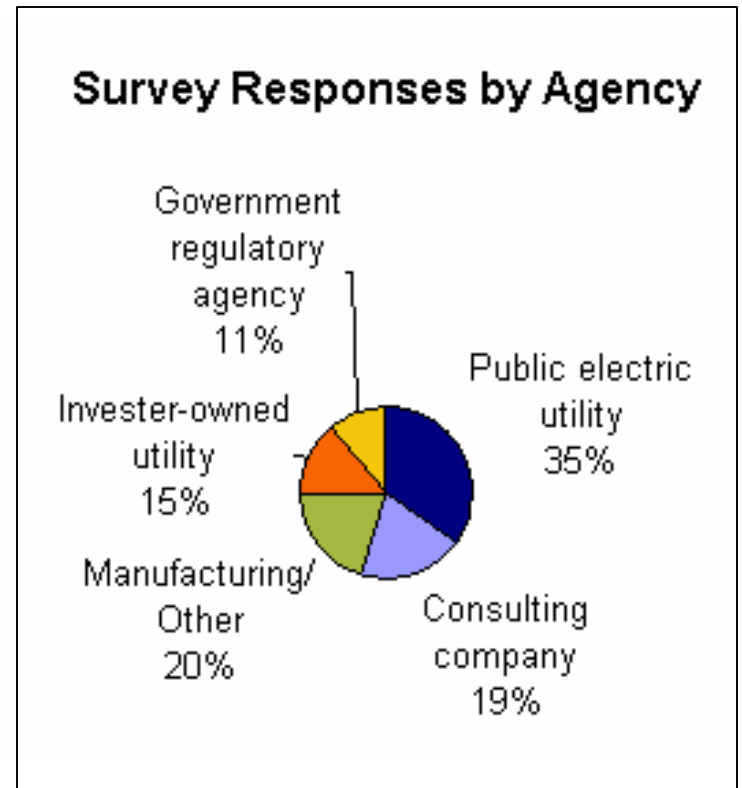
Growth of Texas Electric Transmission Capacity, Generation, and Sales



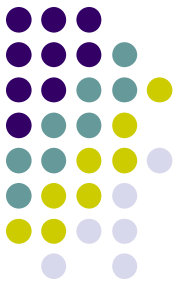


Measure 4: Subjective

- National web-based siting survey of industry experts
- Questions on state siting
 - Familiarity with process
 - Rating of siting difficulty
 - Perception of dominant siting constraint
- Total 1100 state evaluations



Measure 4: Survey Constraints



TLSS Survey - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites History Print Refresh

Address <http://www.ece.cmu.edu/tlss/page2.php> Go

Which one of the following factors do you think contributes most to siting difficulty in this state? (Select one box for each state.)

	Topography / Environment	State Regulation	Federal Regulation	Public Opposition	Inter-Agency Coordination
20. Connecticut	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
21. Maine	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
22. Massachusetts	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
23. New Hampshire	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
24. Rhode Island	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
25. Vermont	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Save and Continue

Done Internet

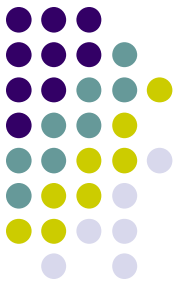


Perceptions of Siting Difficulty

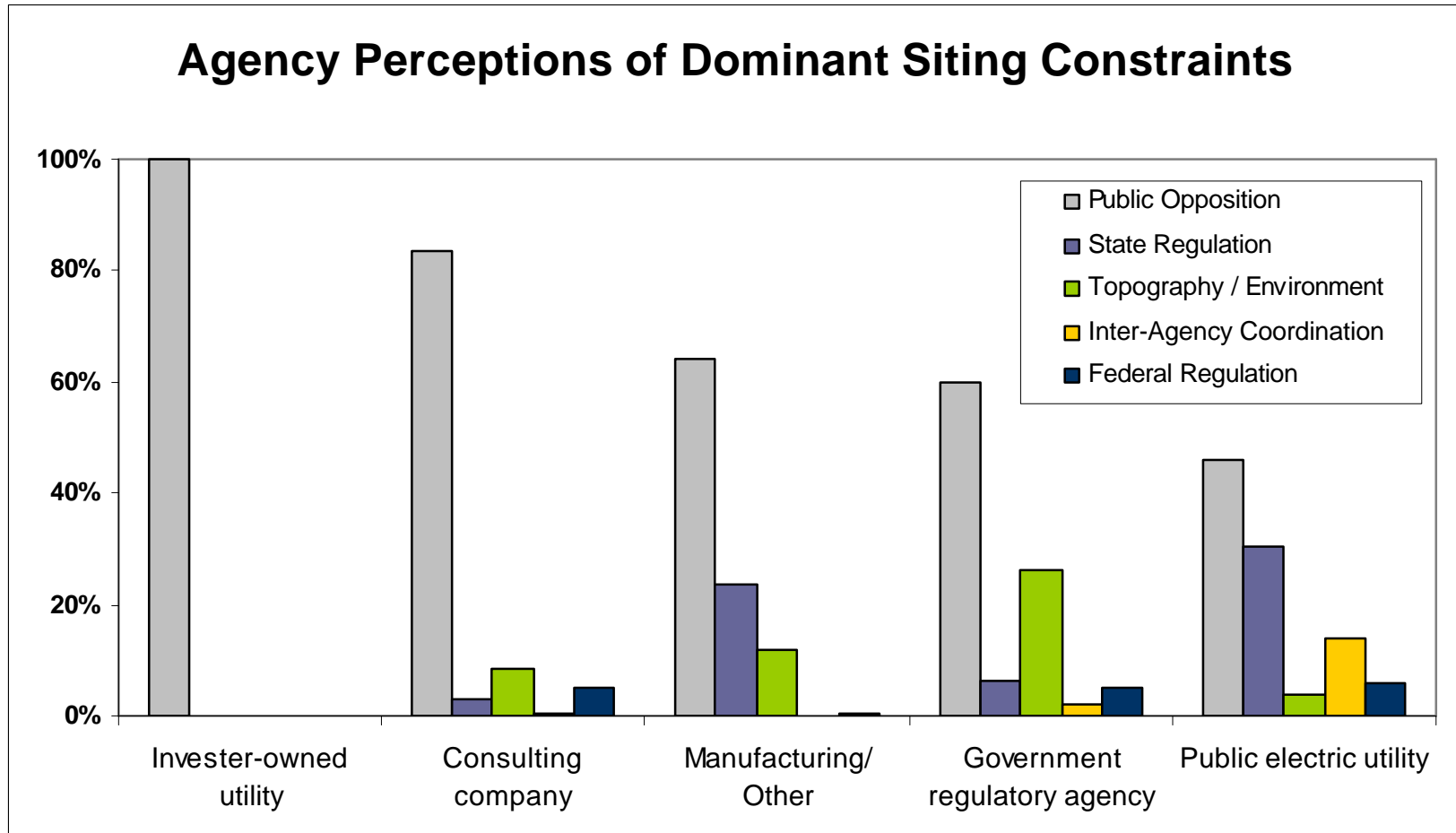
- Average 23 responses per state
 - Familiarity rating scale: 1 (No familiarity) – 5 (Worked on more than three projects in state)
 - Difficulty rating scale: 1 (Easiest) – 10 (Hardest)
- Weighted average of siting difficulty (rank)

State	All Survey Respondents	Consulting Company	Gov't. Regulatory Agency	Public Electric Utility	Investor-Owned Utility	Manufact./ Other
California	7.7 (4)	9.6 (1)	8.2 (7)	6.0 (43)	7.7 (1)	5.6 (31)
Texas	5.7 (45)	7.2 (36)	2.2 (48)	7.0 (34)	5.3 (34)	4.3 (47)

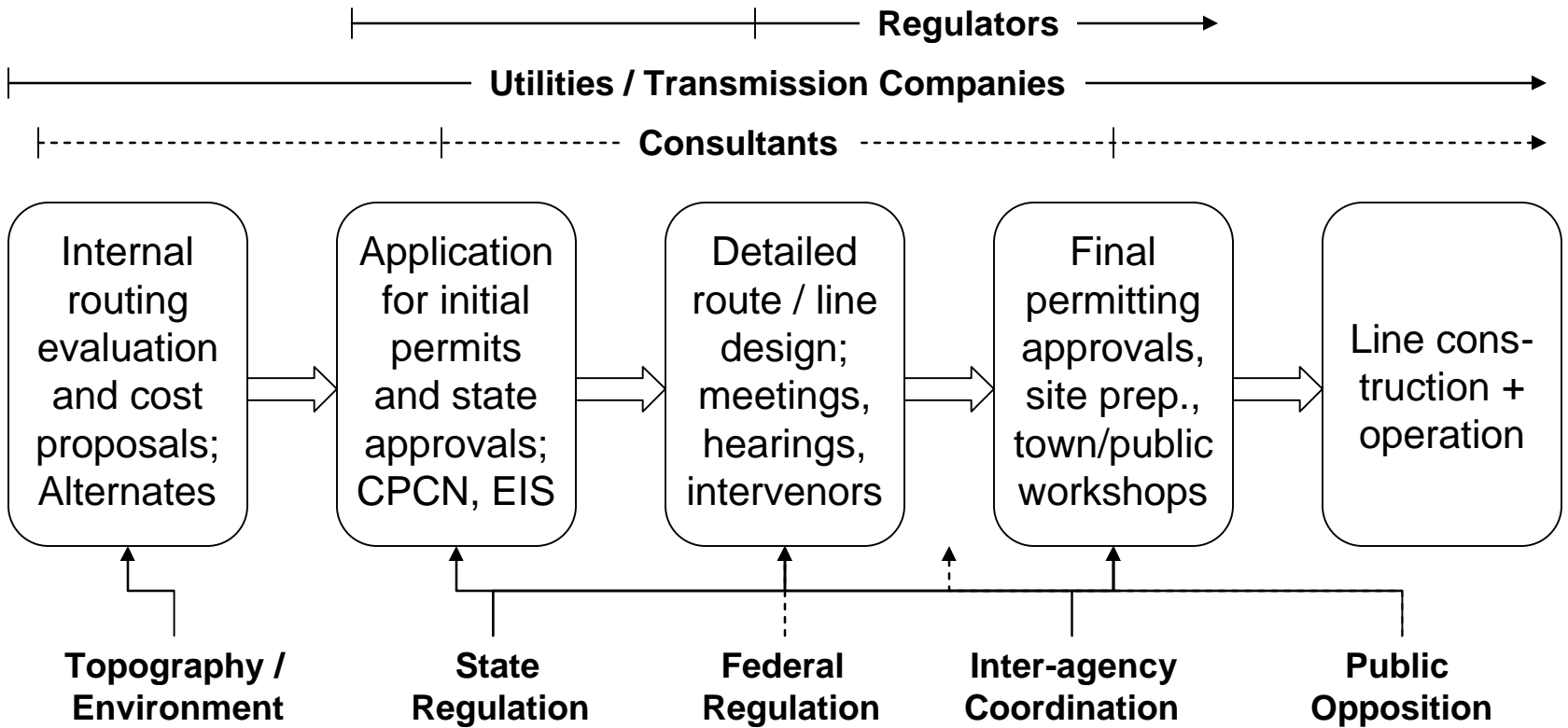
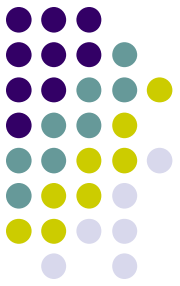
Perceptions of Siting Constraints

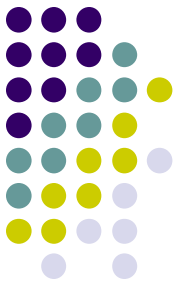


Agency Perceptions of Dominant Siting Constraints



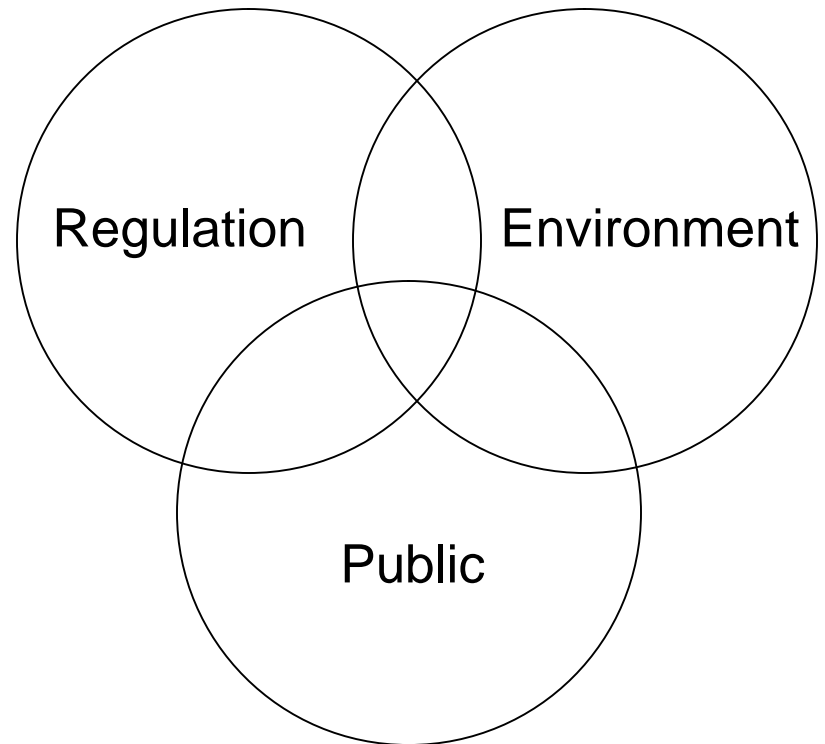
Timeline of Siting Involvement



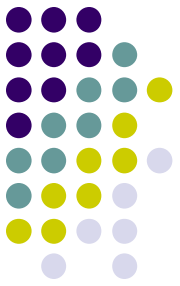


Evaluating Siting Issues

- Indicators and measures of transmission demand, siting difficulty + siting constraints
- Selection of variables for regression + factor analyses
- Aggregate of four indicators to form dependent variables
- Measures of siting constraints as independent variables

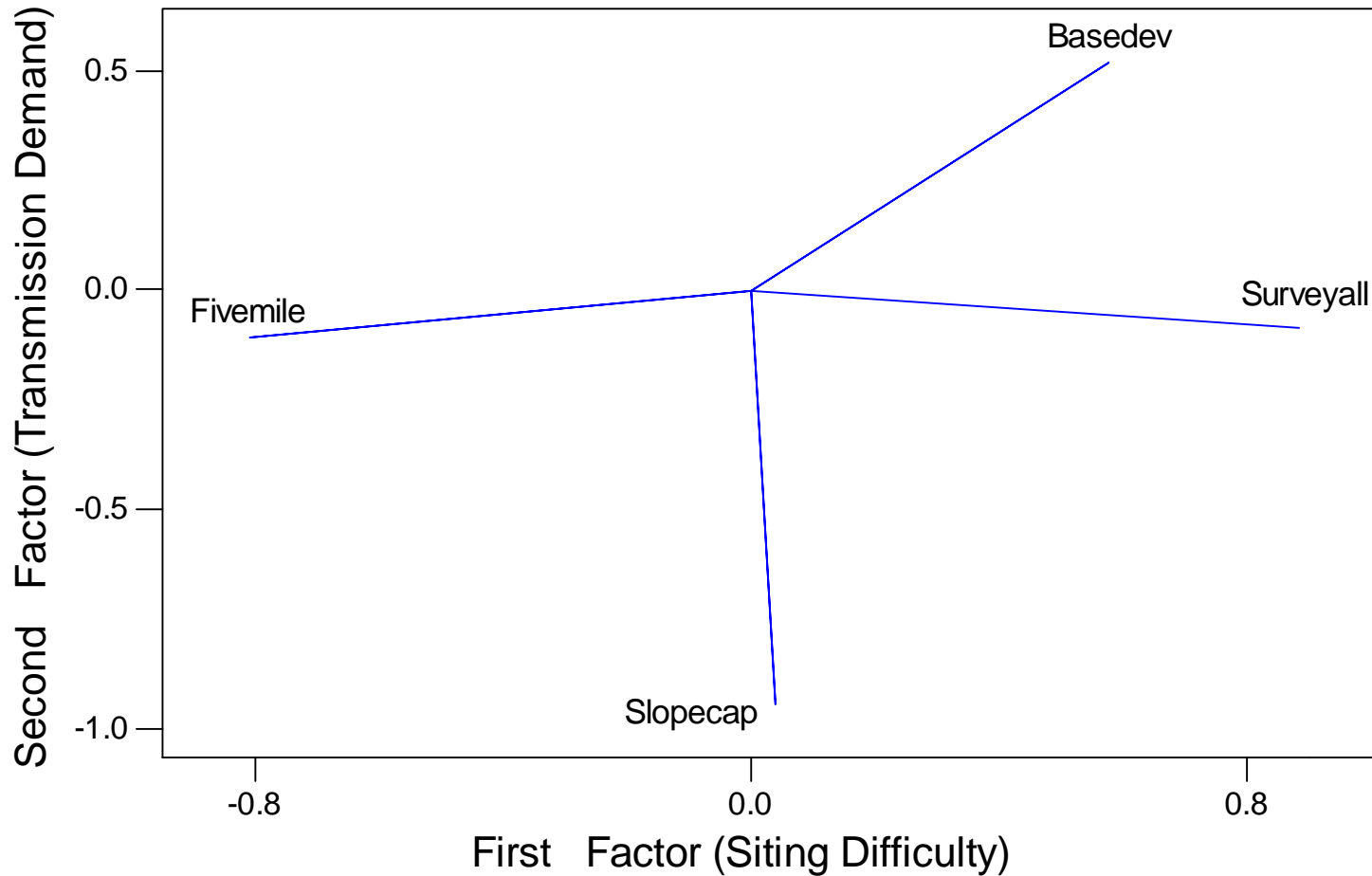
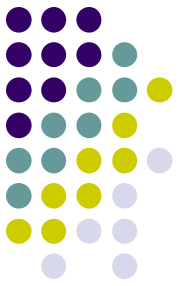


Factor Analysis Results

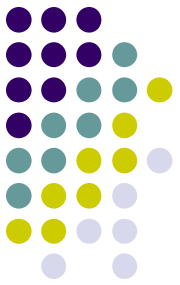


- Dependent Variables (2 Factors)
 - Transmission Demand
 - Economic: Standard deviation baseload cost of production
 - Physical: Slope of generation (MW) to transmission (miles)
 - Siting Difficulty
 - Geographic: Percent state population unserved by 5-mile radius
 - Subjective: Weighted average difficulty (all survey respondents)
- Independent Variables (3 Factors)
 - Public: population density, percent imports, percent exports
 - Environment: percent wilderness area, percent hydro capacity
 - Regulation: number of siting agencies, type of state reg. authority

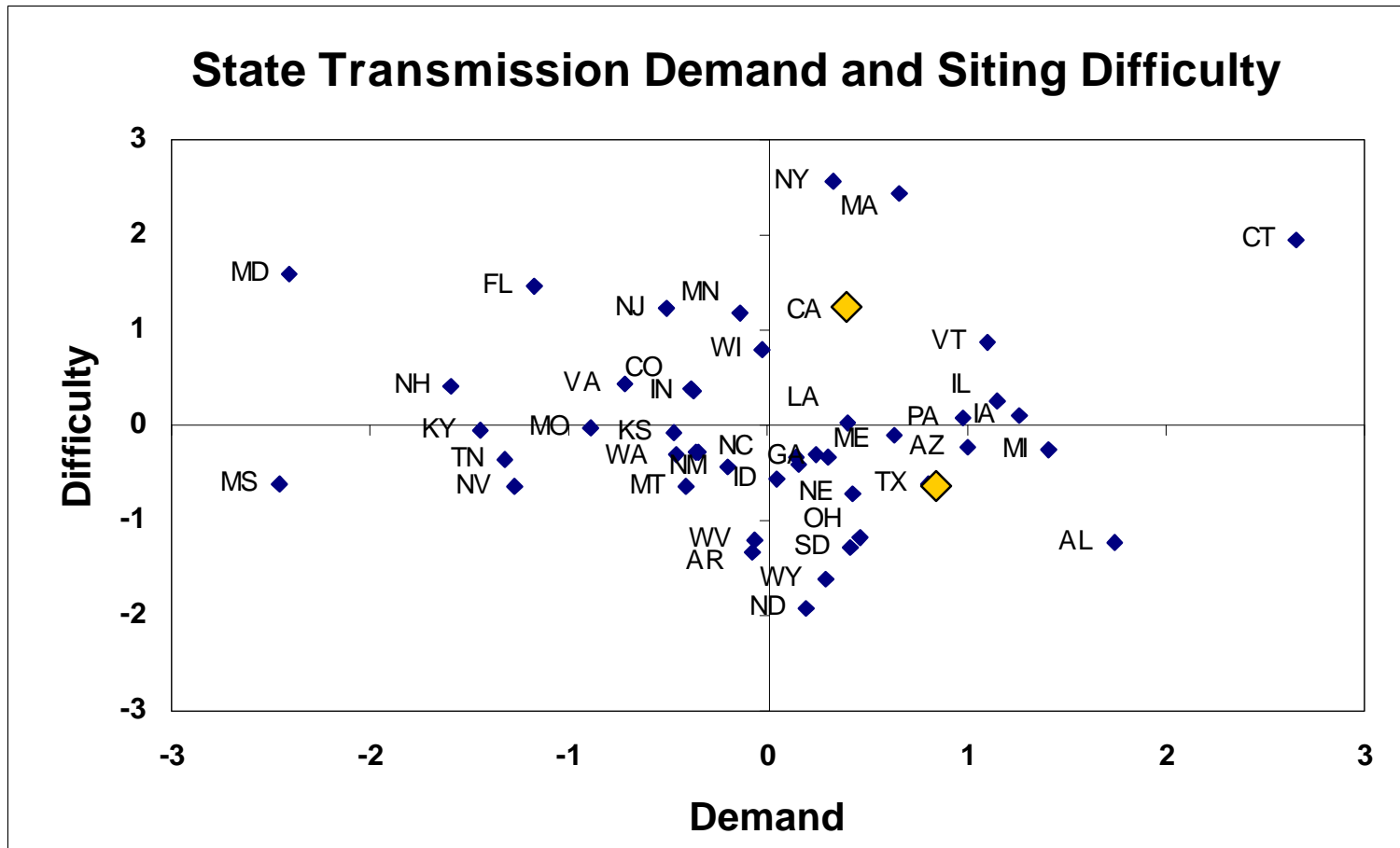
Factor Pattern Loading Plot



Varimax rotated factor pattern: % variance explained = 74%

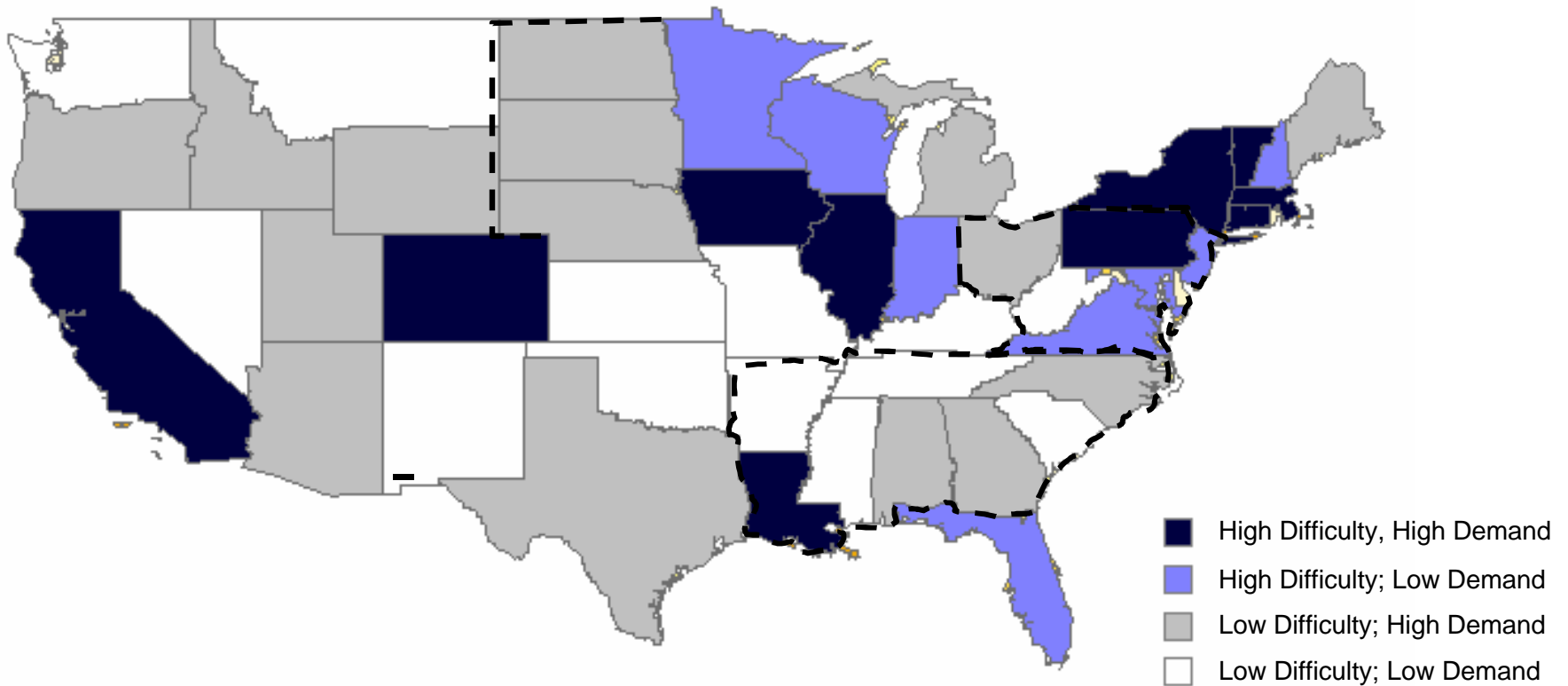
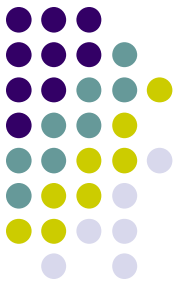


Factor Analysis Score Plot



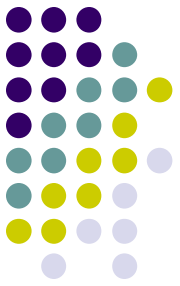
Regression Results: $\text{Difficulty} = 0.68 \cdot \text{Public} + 0.10 \cdot \text{Regs} - 0.17 \cdot \text{Enviro}$ [R²=0.5]

National Map of Siting Difficulty

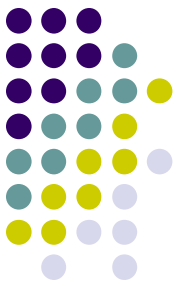


Source Data: RTO boundary definitions from FERC (2003).

Implications for Policy + Regulation



- Review proposed regulatory changes in industry
 - Regional Transmission Organizations (RTO)
 - Identifying siting bottlenecks within a region
 - Coordinate regional planning and siting solutions
 - Federal eminent domain
- Modify timeline of siting process to address siting constraints and perceptions of difficulty
- Improve inter-agency communication and coordination at local, state, and national levels



Conclusions

- Addresses original research questions:
 - How difficult is siting?
 - What makes siting difficult?
 - What can be done to make the process easier?
- Provides quantitative support for existing qualitative information and observations
- Establishes a systematic scale of analysis
- Basis for future comprehensive and comparative transmission and siting analyses

Questions?

