Transmission Line Siting: Analyzing Transmission Demand + Siting Difficulty

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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







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



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 1: Savings Model

CA					CA1	CA2	CA3	CA4	CA5	CA30	CA31		1			
				MW	130	66	72	62	14	106	99					
				HRS	4	5	7	13	15	5210	8733					
					4	1	2	6	2	1994	3523		Total H	rs/Plant		
		MWhr	MW										Optimal	Existing	\$/	MWh
CA1		276,716	86		4	1	2	6	2	1994	3523		8,733	3,216	\$	39.80
CA2		86,562	134		4	1	2	6	2	1776	331		5,323	648	\$	41.20
CA3		3,337	21		4	1	2	6	2	0	0		3,216	162	\$	45.96
CA4		10,722	107		4	1	2	6	2	0	0		2,654	100	\$	46.35
CA5		331	66		4	1	2	6	2	0	0		2,039	5	\$	48.49
CA6		7,676	26		4	1	2	6	2	0	0		1,456	300	\$	49.68
CA7		131,199	90		4	1	2	6	2	0	0		1,392	1,456	\$	52.64
CA8		860,990	- 99		4	1	2	6	2	0	0		750	8,733	\$	57.16
CA9		15,528	17		4	1	2	6	2	0	0		648	904	\$	57.20
CA10		3,115	14		4	1	2	6	2	0	0		648	215	\$	<u>59.92</u>
CA11		240,999	112		4	1	2	6	2	0	0		423	2,148	\$	60.89
CA12		3,843	14		4	1	2	6	2		0		343	271	\$	61.15
CA20		554,379	106		4	1	2	6	2	0	0		164	5,210	\$	112.57
CA21		1,287	13		4	1	2	6	2	0	0		141	97	\$	127.51
CA22		19,098	115		4	1	2	6	2	0	0		106	166	\$	149.05
CA23		4,948	25		4	1	2	6	2	0	0		100	200	\$	153.38
CA24		502	72		4	1	2	6	2	0	0		74	7	\$	157.25
CA25		6,275	31		4	1	2	6	0	0	0		13	205	\$	160.10
CA26		4,189	19		4	1	2	6	0	0	0		13	217	\$	163.95
CA27		2,135	21		4	1	2	1	0	0	0		8	101	\$	186.97
CA28		800	62		4	1	2	0	0	0	0		7	13	\$	228.99
CA29		5,175	46		4	1	0	0	0	0	0		5	113	\$	254.91
CA30		520	130		4	0	0	0	0	0	0		4	4	\$	478.51
CA31		212	14		4	0	0	0	0	0	0		4	15	\$	1,741.59
	MWh	r Sche	duled		7,936	1,854	3,576	10,297	3,309	408,764	347,334	Check	Optimal Cost	Existing Cost	Sa	/ings
		Ne	eded		7,936	1,854	3,576	10,297	3,309	408,764	347,334	0	\$116,424,119	\$175,744,248	\$	59,320,129



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





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 Familiarity



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England					
8					
What is your <u>highest le</u>	evel of familiarity with	the transmissi	on line siting pro	ocess for each o	of the states
below? (Check <u>one</u> box	c for each state).				
	No familiarity	Info from Modia/	Info from	Worked on	Worked on more than 3
	No familiarity with siting in this state	Info from Media/ Literature	Info from colleagues/ friends	Worked on 1-3 siting projects	Worked on more than 3 siting projects
8. Connecticut	No familiarity with siting in this state O	Info from Media/ Literature C	Info from colleagues/ friends C	Worked on 1-3 siting projects C	Worked on more than 3 siting projects C
8. Connecticut 9. Maine	No familiarity with siting in this state O	Info from Media/ Literature C	Info from colleagues/ friends C	Worked on 1-3 siting projects O	Worked on more than 3 siting projects C
8. Connecticut 9. Maine 10. Massachusetts	No familiarity with siting in this state O O	Info from Media/ Literature C C	Info from colleagues/ friends C C	Worked on 1-3 siting projects C C	Worked on more than 3 siting projects C C
8. Connecticut 9. Maine 10. Massachusetts 11. New Hampshire	No familiarity with siting in this state O O O	Info from Media/ Literature C C C	Info from colleagues/ friends C C C	Worked on 1-3 siting projects C C C	Worked on more than 3 siting projects C C C
8. Connecticut 9. Maine 10. Massachusetts 11. New Hampshire 12. Rhode Island	No familiarity with siting in this state O O O O	Info from Media/ Literature C C C C C	Info from colleagues/ friends C C C C	Worked on 1-3 siting projects C C C C	Worked on more than 3 siting projects C C C C C



Measure 4: Survey Difficulty

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Based on your understa transmission line siting	inding of si in each of t	ting in the stat	this sta tes belo	ate, wh ow? (C	at do y hoose	ou thin one nw	k is the mber fo	e relati or each	ve levo 1 state.	el of difficul)	ty for
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	1	2	3	4	5	6	7	8	9	10	
14. Connecticut	0	0	С	0	0	0	0	0	0	0	
15. Maine	С	0	С	0	0	0	0	0	С	C	
16. Massachusetts	С	0	0	0	0	0	0	0	0	0	
17. New Hampshire	С	0	0	0	0	0	0	0	0	0	
18. Rhode Island	С	0	0	0	0	0	0	0	0	0	
172022	0	0	0	0	0	0	0	0	0	0	
19. Vermont											

Measure 4: Survey Constraints

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Which one of the following one box for each state.)	g factors do you th	ink contribute	s most to siting	difficulty in th	is state? (Select	
	Topography / Environment	State Regulation	Federal Regulation	Public Opposition	Inter-Agency Coordination	
20. Connecticut	C	О	С	0	C	
21. Maine	С	С	C	C	С	
22. Massachusetts	С	C	C	0	С	
23. New Hampshire	c	С	C	С	o	
24. Rhode Island	С	c	C	С	o	
25. Vermont	C	С	C	c	C	

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



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





Factor Analysis Score Plot



Regression Results: Difficulty = 0.68*Public + 0.10*Regs – 0.17 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?