Area Investment Strategy Model Training Workshop: Tools for DR Evaluation

December 2000

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Agenda

- ⇒ Workshop objectives
- Steps to learning to use the model
- Methodology background
- Tutorials
- Hands-on work

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Workshop Objectives

- Show you how to use the model
- Demonstrate some of the research insights that have been generated from the development and application of the model
  - value of learning
  - value of modularity

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Learning To Use The Model

- Study Chapter 3 - basic concepts
- Review Chapter 2 to become familiar with the user interface
- Do the first tutorial, Chapter 4
- Do the second tutorial, Chapter 5 - real utility example

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Planning Problem

- Economic value of distribution infrastructure investments is affected by the uncertainty in future load
- Thus, when planning long term capacity investment, economic evaluations must include a characterization of possible future load levels
- The question are:
  - How to build the load uncertainty information into the economic analysis?
  - How to design least-cost investment strategies?
- Accommodate the need to evaluate non-traditional options such as distributed generation

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New focus: DR as a strategy

- Reformulate distribution and DR planning
- The analytical problem

Reformulate Distribution and DR Planning

- Focus on distribution
- Structure problem
- Minimize costs & remove deferral bias
- Base analysis on actual cash flows
- Explicitly treat uncertainty
- Find least cost plans that integrate DR and traditional investments

Analytical problem

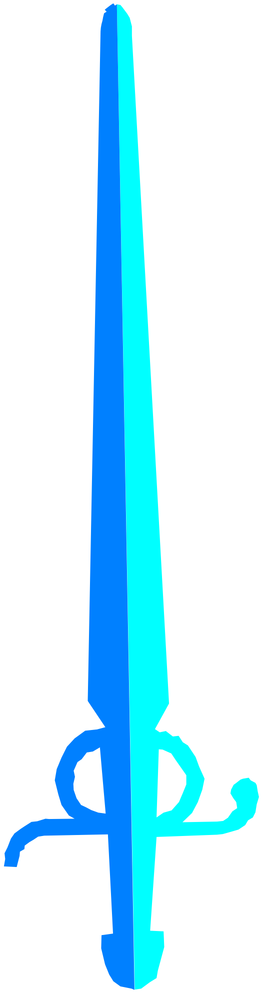
- Valuation principles
- Economies of scale
- Limitation of scope
- Uncertainty

Investment Planning First Principles

- Deferral has direct economic value - opportunity cost of $
  - the higher the cost of $ the greater the value of deferral
  - lumpy investments OK if used some day
- There is a tradeoff between economy of scale and flexibility
  - big resources are generally cheaper but provide no flexibility
  - small investments defer big investments and provide option to revisit big decision
  - option to delay allows learning before deciding
- The value of being able to revisit depends on nature of uncertainty
  - EV, VAR, CORR, Type of Event
  - no uncertainty no value
- Independent of uncertainty, modularity has value
  - easier siting
  - tracks load better

Economy of Scale - The Two-edged Sword

- When to invest in the big stuff?
- Type I Error: convict the innocent
  - avoid investment because first cost is too large
  - this ignores benefits of economies of scale
- Type II Error: release the guilty
  - make investment because the $/kW is small
  - but what if load growth is small or very uncertain?
  - if so, large capital cost for unused capacity for a long time



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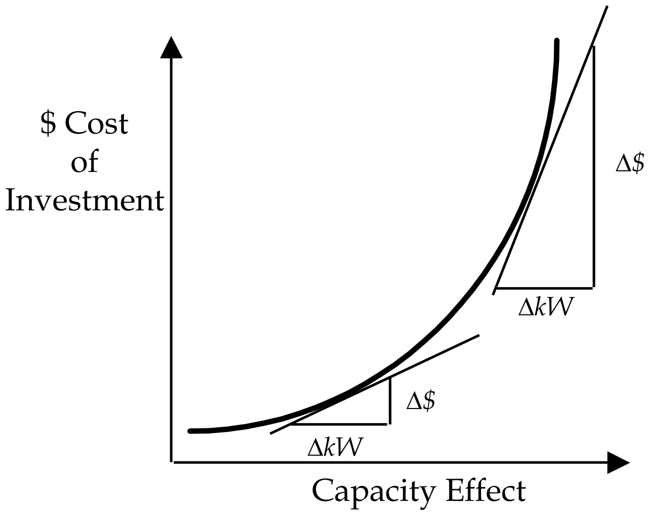
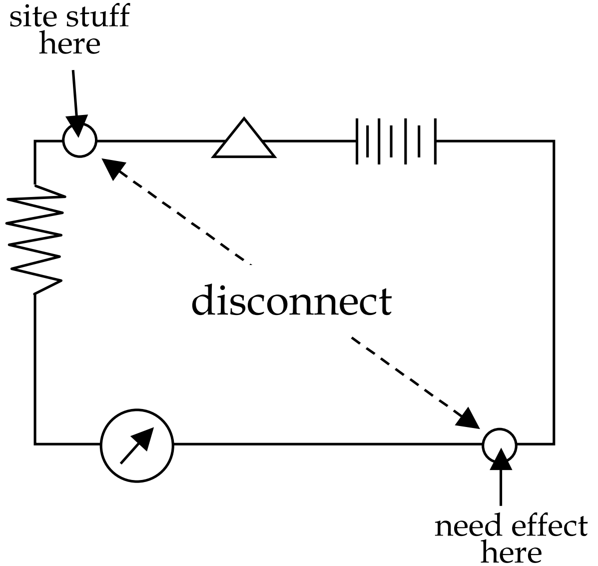
Limitation of Scope - Cost Versus Capacity Effect

- Part I: For DSM & modular investments, increasing costs for a fixed capacity effect

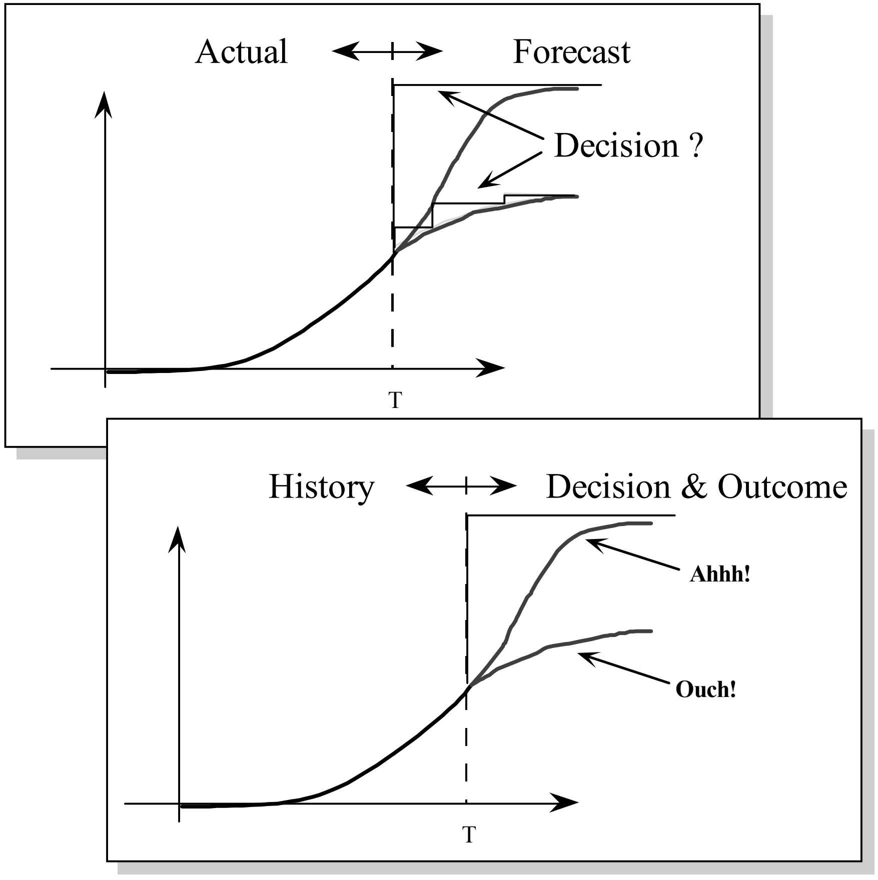


- Part II: Can the modular & DSM investments be located where the capacity needs exist?
  - Yes, but the effect saturates
  - No, so the effect is strictly limited (capacity need but energy benefit)



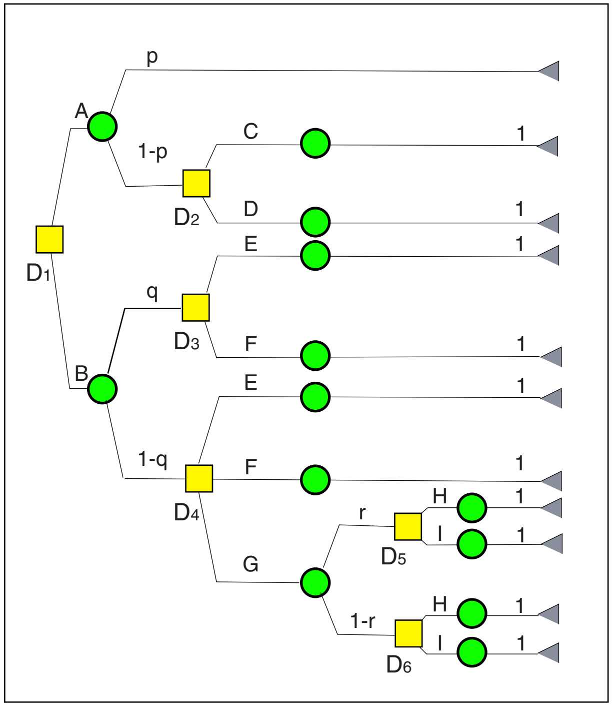
The Uncertain Load Problem

- Uncertain load and lumpy investments create a planning challenge
  - future load is probabilistic
    - » can identify the potential for growth
    - » but cannot accurately predict if and when it will occur
- The need for new capacity depends on future load growth
- Thus investment value is probabilistic and risky



New Methodology

- Purpose
  - Can the system be made more efficient without sacrificing reliability and quality of service?
  - Find least-cost plan under uncertainty
  - Timed sequence of investments that are contingent of various states of nature
- Overview of model operation
  - Dynamic optimization represented as a decision tree
  - Series of nodes (decision - uncertainty - decision - etc.)



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Real Utility Example

- Assumptions
- Case 1: No salvage of DR
- Case 2: Salvage of DR
- Case 3: No learning

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Assumptions

ASSUMPTIONS – CASES 1 & 2			
Technologies (Capacity Alternatives)	***Life***	*Size (kW)*	*Cost ($1000)*
S: Substation	40	20,000	$2,000
F: Feeder	30	6,000	$900
E1: Engine 1	30	3,000	$1,500
E2: Engine 2	30	1,500	$750
E3: Engine 3	30	3,000	$2,250
E4: Engine 4	30	3,000	$2,500
Trend Transition Probabilities (Load Growth Specifications)			
	Low (1%)	*Medium (2%)*	*High (5%)*
Low (1%)	0.75	0.25	0.00
Medium (2%)	0.125	0.75	0.125
High (5%)	0.00	0.25	0.75
Initial Load Growth Rate		"Low" 1%	

COMMON ASSUMPTIONS FOR STUDY		
Time Horizon	12 years	
Discount Rate	5.77%	
Inflation Rate	4%	
Accounting Method	Before Tax Cash Flow	
Initial Load	44,608 kW	
Maximum Area Load	70,000 kW	
Saturation On-Set Load	60,000 kW	
Terminal Value Specifications		
1. Price of Capacity at Terminal Time	$10/kW-yr	
2. Escalation on Price of Capacity	1.0	
3. Operating Cost of Capacity	$0.02/kWh	
4. Escalation on Operations Cost	1.0	
CHAPTER 1 inal Load Growth Rate	1%	
Variable O&M Cost – S & F	$0.02/kWh	
Variable O&M Cost – Engines	$0.05/kWh	
System Avoided Costs	$0.02/kWh	
Emissions Costs	0	
Load Shape	*Time (hrs)*	*% of Peak*
	0	100%
	88	95%
	264	90%
	8759	25%
	8760	0%
Load Growth Trends		
	Growth Rate	
Low	1.01 (1%)	
Medium	1.0201 (2%)	
High	1.051 (5%)	

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Case 1 "No Salvage"

- Engines are constrained to remain in place once installed
- Least-cost policy: install 20 mw substation

Decision (Stage 1)	Chance	Decision (Stage 2)
PV Cost = 6086.23		
S at t=0.00, L=44608	p=0.139, t=29.59, g=1.013	Terminate at t=12, L=51838
	p=0.567; t=20.62; g=1.018	Terminate at t=12; L=55342
	p=0.294; t=12.40; g=1.030	Terminate at t=12; L=63832

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Case 2: "Salvage"

- Engines can be removed and reused
- Least-cost policy depends on evolution of load growth

Decision (Stage 1)	Decision (Stage 2)	Decision (Stage 3)	Decision (Stage 4)
PV Cost 4800.57 E1	E2	S(-E1, -E2) S(-E1, -E2) S(-E1, -E2)	T T T
	E2	S(-E1, -E2) S(-E1, -E2) S(-E1, -E2)	T T T
	E2	S(-E1, -E2) S(-E1, -E2) S(-E1, -E2)	T T T T E1

[1] (-E1, -E2) means that the two engines are removed (salvaged) and replaced by the feeder and substation investments in stage 3. This allows the same engines to be used in subsequent stages.
Note: this table provides the results through Decision Stage 4.

Case 3: "No Learning"

- No trends in load growth
- Learn nothing by waiting
- Results: least-cost policy is same as before
  - Install engines
  - When growth exhausts engine capacity, install substation
- Costs are higher

ASSUMPTIONS – CASES 3

Trend Transition Probabilities
(Load Growth Specifications)

	Low (1%)	*Medium (2%)*	*High (5%)*
Low (1%)	0.25	0. 50	0. 25
Medium (2%)	0. 25	0. 50	0. 25
High (5%)	0. 25	0. 50	0. 25
Initial Load Growth Rate		"Low" 1%	

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