Decision Making Under Uncertainty

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Northwest Power and Conservation Council

Overview

- Review
- New Considerations
- The Action Plan and Long-Term Adequacy

Northwest Power and Conservation Council

Review

- We make decisions under uncertainty every day. Many of the principles for evaluating resource plans are the same.
- One of our primary goals is to determine the trade-off between costs and risks of specific resource plans.

Review

- Currently, there seems to be a relatively small trade-off between risk and cost
  - The region is in a period of relative surplus, expected to last through 2008 and beyond.
  - The further out in time we add resources, the less they cost in today's dollars.
  - In a period of surplus, prices tend to be less volatile.
  - In a period of surplus, the main risk is fixed-price risk, and the plans represented by the trade-off curve have very little conventional resource capacity.

Review

- Action Plan
  - DR could significantly reduce both risk *and* cost, but we need to learn more now about the cost and potential for later implementation
  - Aggressive pursuit of lost opportunity conservation has both cost and risk advantages
  - The region appears to have sufficient conventional resources for the next four to five years, although individual load-serving entities or customers may have vastly different risk-management situations
  - Evaluate the role of transmission for resources that will be completed before 2013

Review

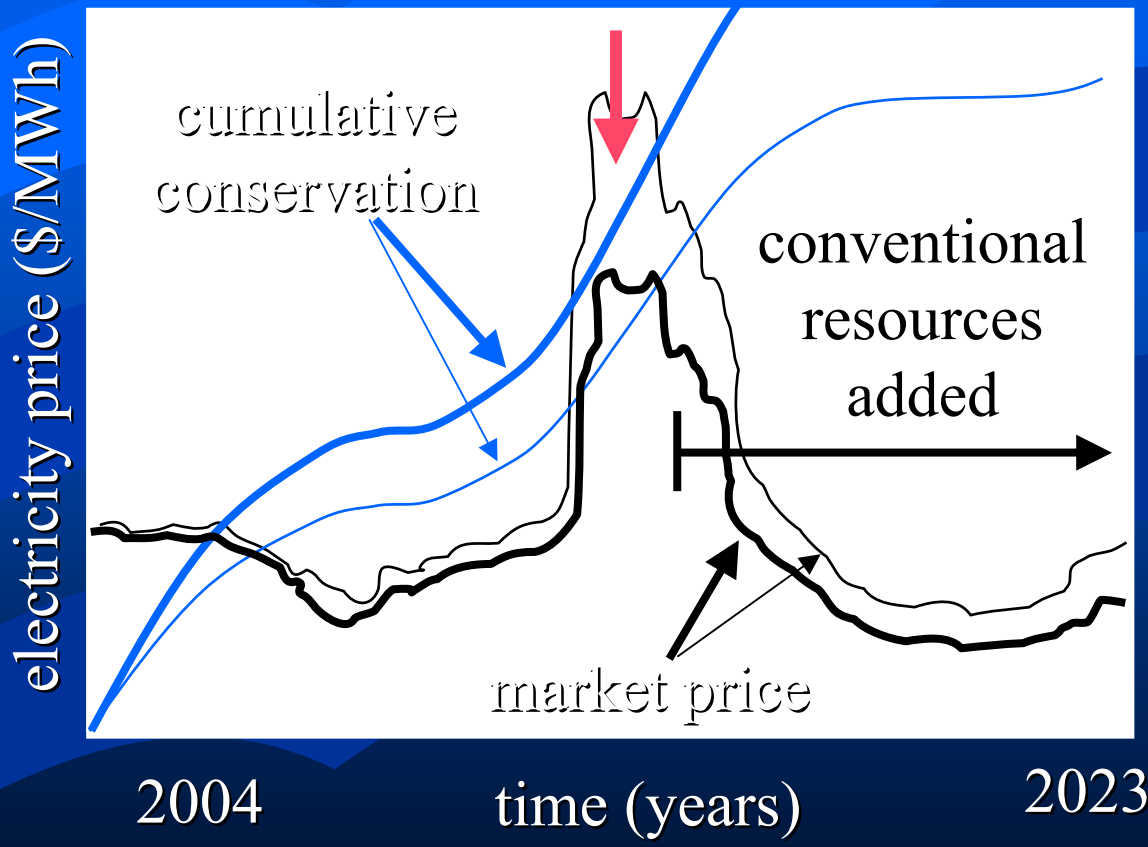
- Portfolio studies consistently concluded that aggressive pursuit of lost opportunity conservation reduces risk and cost.
- Conservation differs from other resources in several important ways.
  - The amount of conservation that you can develop, in particular lost-opportunity conservation, depends on history.
  - Conservation is assumed to be available from a host of different programs with different costs, giving rise to a non-trivial supply curve.

Conservation Has Unique Advantages

- If the supply curve is more or less continuous, increments of "above market" conservation can be added inexpensively.
  - This can make conservation an inexpensive source of *reserve margin*, which reduces market exposure risk and may moderate wholesale price swings.

The Value of Conservation as Reserve Margin Contribution

- The value stems from "being there" when a shortage hits
- Higher levels of conservation provide more price moderation



Overview

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New Considerations

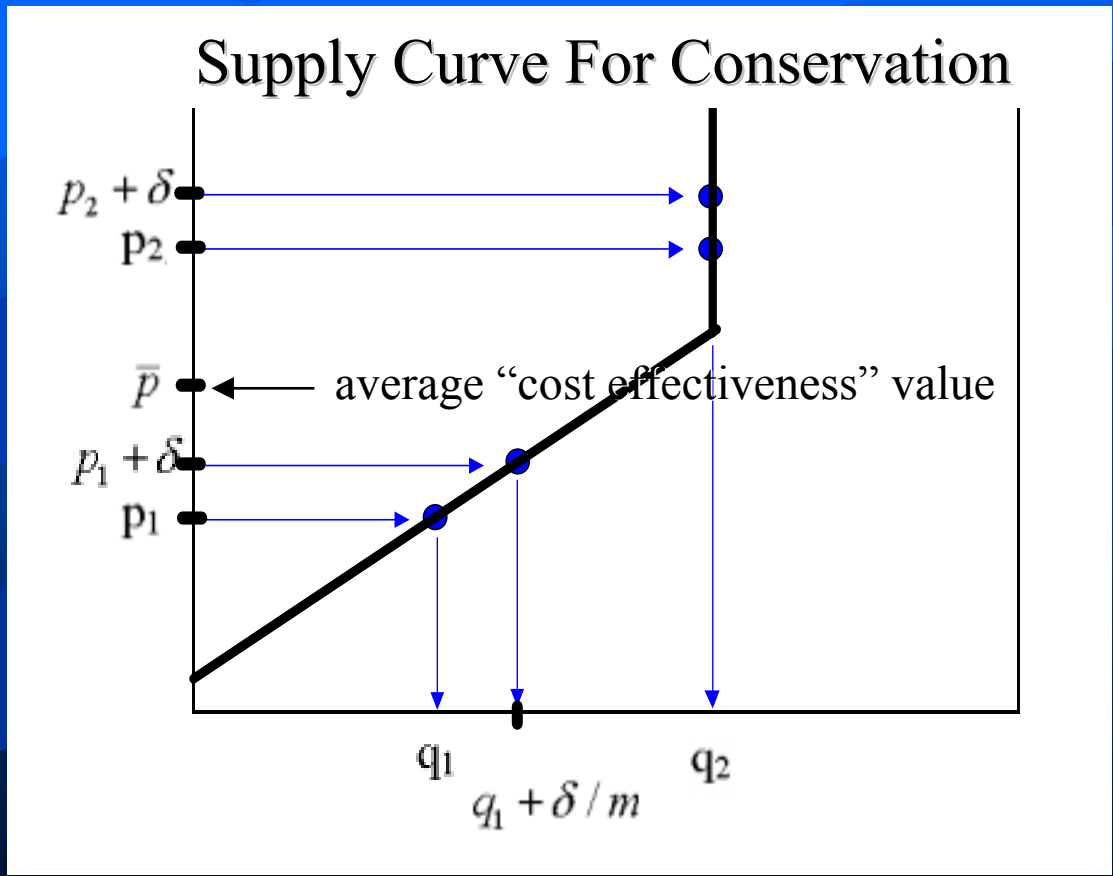
- More insights into the value of conservation
- "New" planning criterion
- Probabilistic Treatment of Production Tax Credits, wind integration costs, and Green Tag trading values
- Sensitivity analysis and calibration with other models

Conservation Has Unique Advantages

- If the supply curve has the typical concave shape associated with increasing marginal cost, sustained development can result in lower cost.
- A policy of *sustained* acquisition means we do *not* forego opportunities to acquire conservation when its cost and apparent value are less.

Getting Conservation "Cheap"

- Here, the δ represents a premium over our "cost effectiveness" standard, which changes as circumstances change.

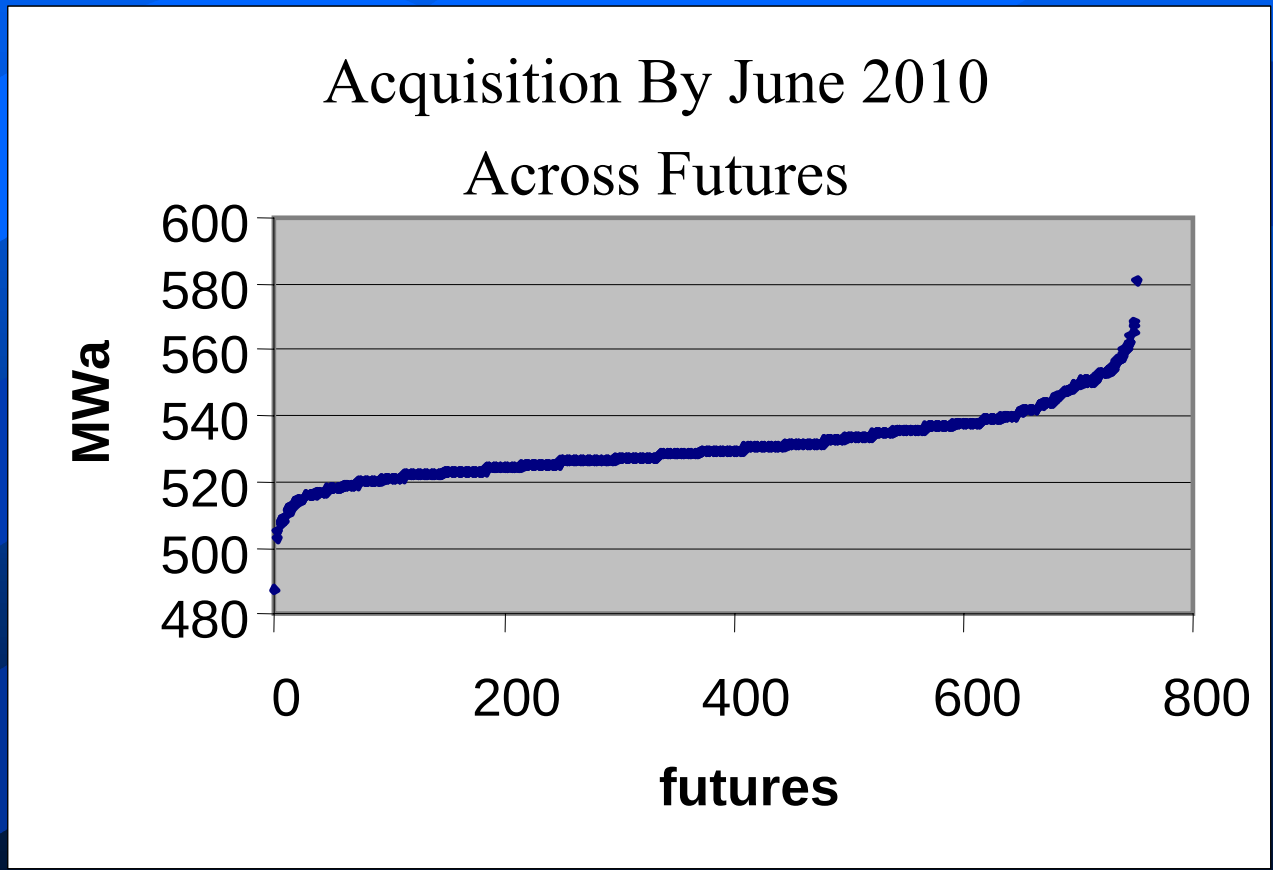


Consequences of Sustained Acquisition of Conservation

- Our portfolio studies have suggested paying a premium of up to 40 $/MWh (!!) has cost and risk advantages
- Analysis has revealed that, because our supply curve for conservation is concave, this policy really amounts to buying more than we would have when cost effectiveness levels were low and not much at all when cost effectiveness levels are high. That is, our acquisition rates get "flattened out"
  - This brings us back to the notion of "sustained orderly development."

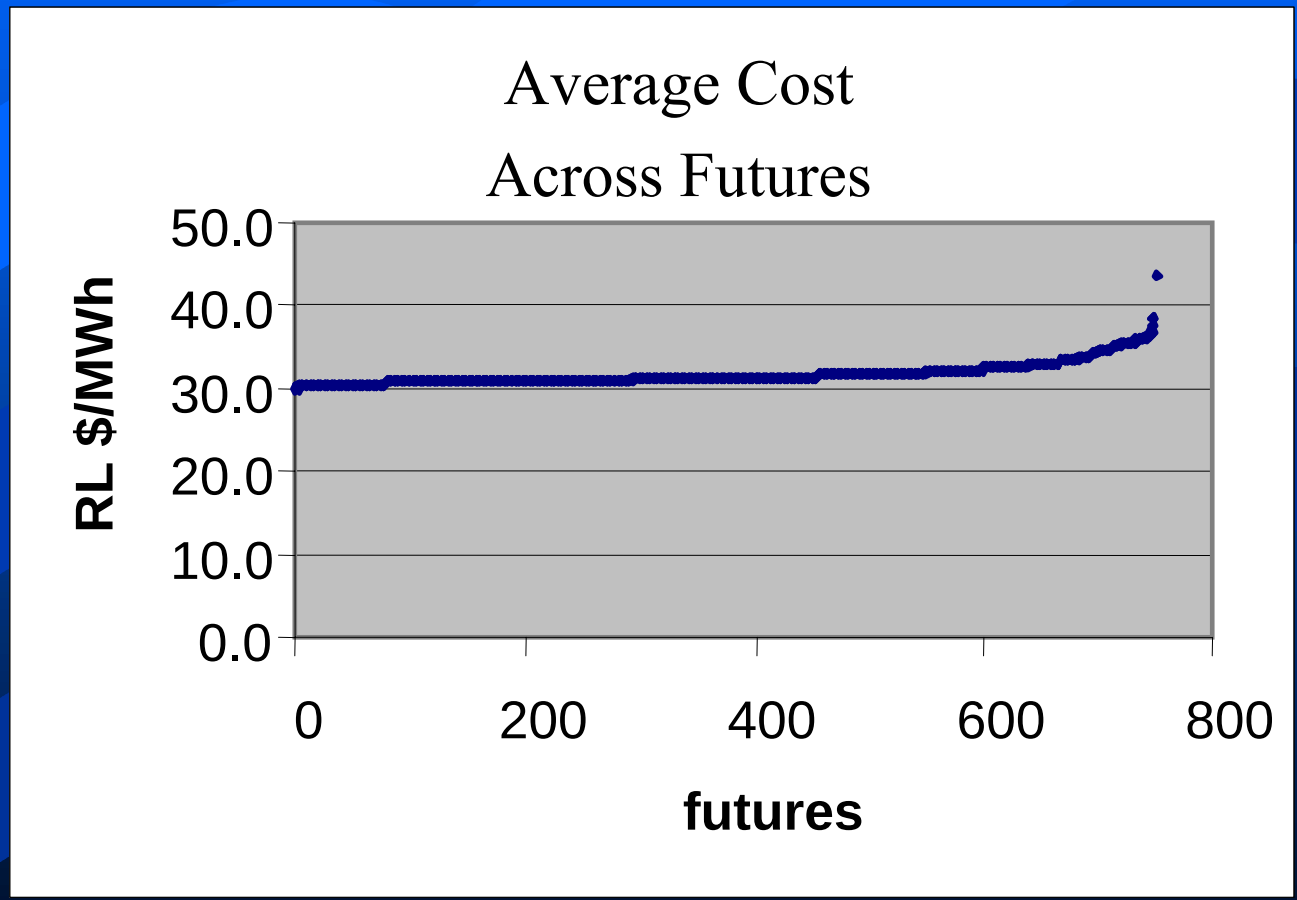
Consequences of Sustained Acquisition of Conservation

- Median rate: 75 MWa per year
- Maximum rate: 82 MWa per year



Cost of Sustained Acquisition of Conservation

- Median rate: 32 $/MWh
- Maximum rate: 43 $/MWh



Conclusions Regarding Conservation

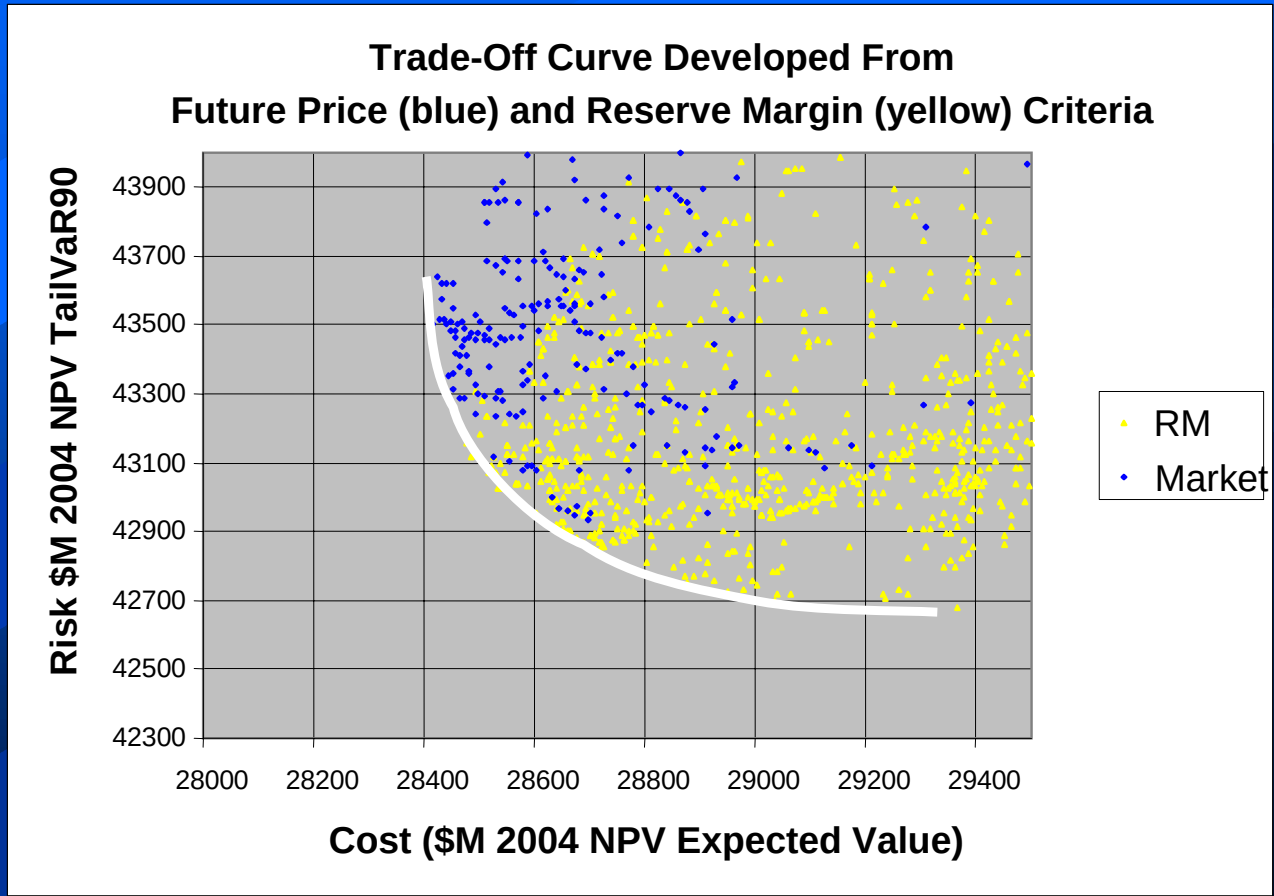
- "Aggressive pursuit of conservation continues to have cost and risk advantages"
- This policy is consistent with our current cost effectiveness threshold of about $37/MWh or lost opportunity acquisition target of 75 MWa/year
- Not elsewhere discussed here: Schedulable conservation target would be about 80MWa per year at an average cost of $14/MWh

"New" Planning Criterion

- Our resource plans implicitly assume a rule for deciding when to add resources
- Until March, we have used expected future market prices to determine when resources are added
- Our recent studies using reserve margin criteria, that is, critical water total resources surplus to requirements, can result in a lower-risk plan

"New" Planning Criterion

- Using reserve margin tends to give us more expensive, but less risky plans



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Other New Considerations

- Probabilistic treatment of Production Tax Credits, wind integration costs, and Green Tag trading values
- Sensitivity analysis and calibration with other models
  - Duration of electricity price jumps,
  - Natural gas price volatility,
  - CO_2 uncertainty

Probabilistic treatment of Renewables incentives

- When a carbon tax or emission trading program is implemented in a future, the production tax credit and green tag incentives are removed. The integration costs continue.
- PTC: averages $7.80/MWh; varies from $4.80 to $10.80/MWh
- Integration: most likely value is $4.00/MWh; varies from $2.00/MWh to $10.00/MWh
- Green tag value: uses Jeff Kings most likely projection ($6.66/MWh in 2004 to $20.13 /MWh in 2023) but can vary by 50 percent

Typical Low-Risk Resource Construction Schedule

Resource	Characteristics	12/07	12/09	12/11	12/13	12/15	12/17	12/19
Gas CCCT	High efficiency, moderate capital cost, moderate lead time, moderate fuel cost			1000				
Gas SCCT	Moderate efficiency, low capital cost, short lead time, high fuel cost							0
Coal	Moderate efficiency, high capital cost, long lead time, low fuel cost			500				500
Wind	High capital cost, short lead time, zero fuel costs, intermittent				500		3500	
Conservation	*Cumulative* total:	567	891	1215	1539	1863	2187	2511

CCCT, SCCT, Coal, and Wind are incremental, calendar year additions (MW); Conservation is cumulative (MWa)

These dates represent the earliest that construction would begin. The earliest in-service dates are 2 years later for CCCT, 1 year for SCCT, 3 years six months for Coal, and 1 year for Wind, due to construction time requirements.

Duration of Electricity Price jumps

- We model wholesale power prices as responsive to natural gas prices, PNW loads, and hydro generation
- We also include an independent term of variation and uncertainty that is intended to capture all the other influences: new technology breakthroughs, regulatory innovations, resource and demand changes outside the region, and so forth
- The independent term includes jumps that last 1-3 years that are intended to capture long-term disequilibrium in the power market
- How sensitive are our conclusions to the duration of the price jumps in the independent term?

Cutting the Duration of Electricity Price Jumps in Half

Resource	Characteristics	12/07	12/09	12/11	12/13	12/15	12/17	12/19
Gas CCCT	High efficiency, moderate capital cost, moderate lead time, moderate fuel cost			500		500		
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Coal	Moderate efficiency, high capital cost, long lead time, low fuel cost			500				
Wind	High capital cost, short lead time, zero fuel costs, intermittent				1000		3000	
Conservation	*Cumulative* total:	553	869	1185	1501	1817	2133	2449

- Less or delayed resources, none planned to begin construction before Dec 2011

Natural Gas Price Uncertainty

- What would the resource planning outcome be if gas prices were $1.50/MMBTU higher on average than we had assumed in our distribution?

Natural Gas Price Uncertainty

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- Gas pushed off a bit, more wind

CO_2 Uncertainty
No CO_2 Tax

Resource	Characteristics	12/07	12/09	12/11	12/13	12/15	12/17	12/19
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Conservation	*Cumulative* total:	567	891	1215	1539	1863	2187	2511

- In the event that we could be certain that there would be no CO2, but incentives would remain, there is little change in our plan.

CO_2 Uncertainty McCain-Lieberman

- We examined the consequences of the McCain-Lieberman proposal for reducing greenhouse gases (Paltsev, et.al., "**Emissions Trading to Reduce Greenhouse Gas Emissions in the United States: *The McCain-Lieberman Proposal,"*** from MIT Joint Program on the Science and Policy of Global Change, Report 97, June 2003)
- The future we considered is referred to as Phase I and II target, banking, applied to all GHGs, which calls for $25/ton CO_2 by 2010; $32/ton by 2015; and $40/ton by 2020, all in 1997 dollars. (2004 dollars are about 18% higher)

CO_2 Uncertainty McCain-Lieberman

Resource	Characteristics	12/07	12/09	12/11	12/13	12/15	12/17	12/19
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Wind	High capital cost, short lead time, zero fuel costs, intermittent				1000		3000	
Conservation	*Cumulative* total:	630	990	1350	1710	2070	2430	2790

- More Gas CCCTs, no coal, more wind and conservation. Gas CCCTs are displacing coal and less efficient CCCTs. No resource construction before 2011.

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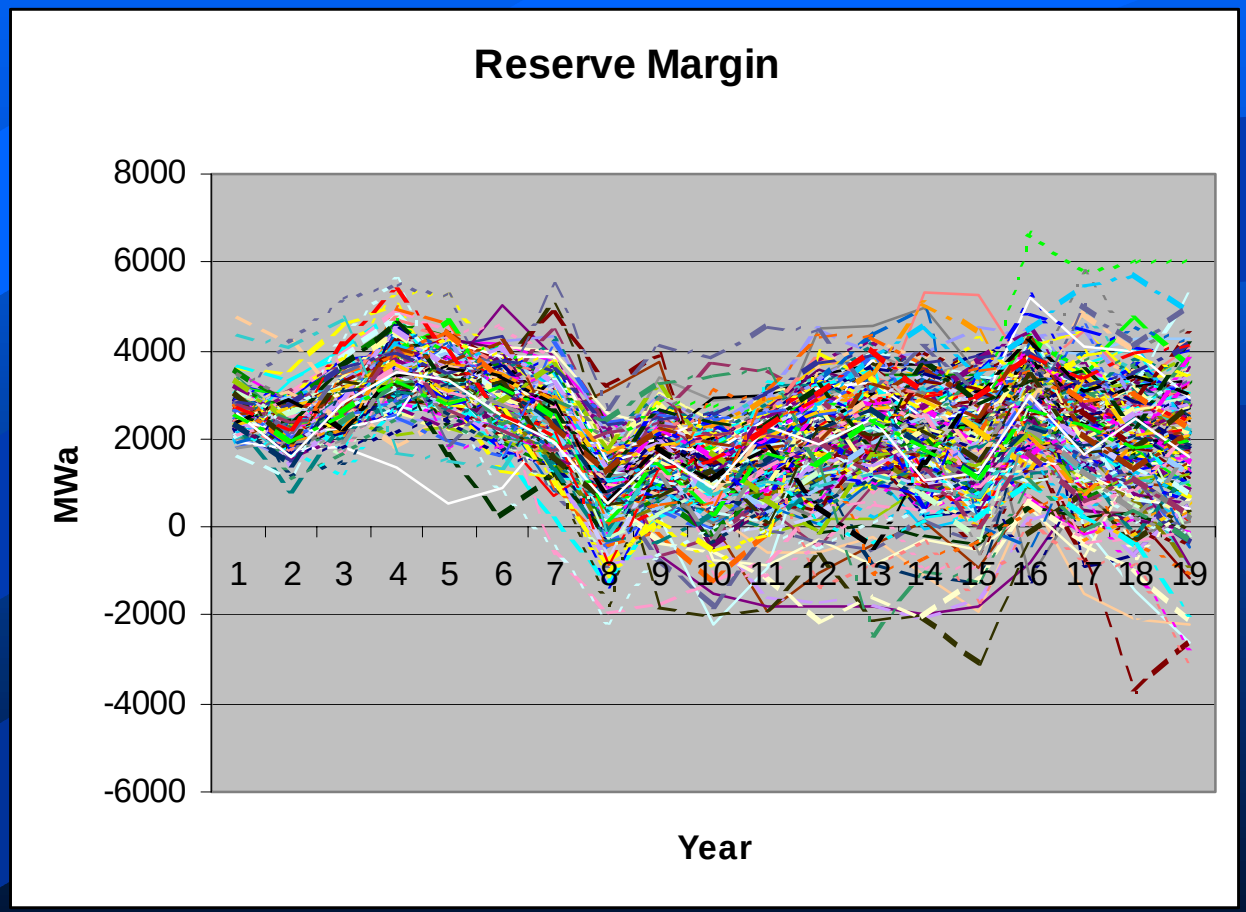
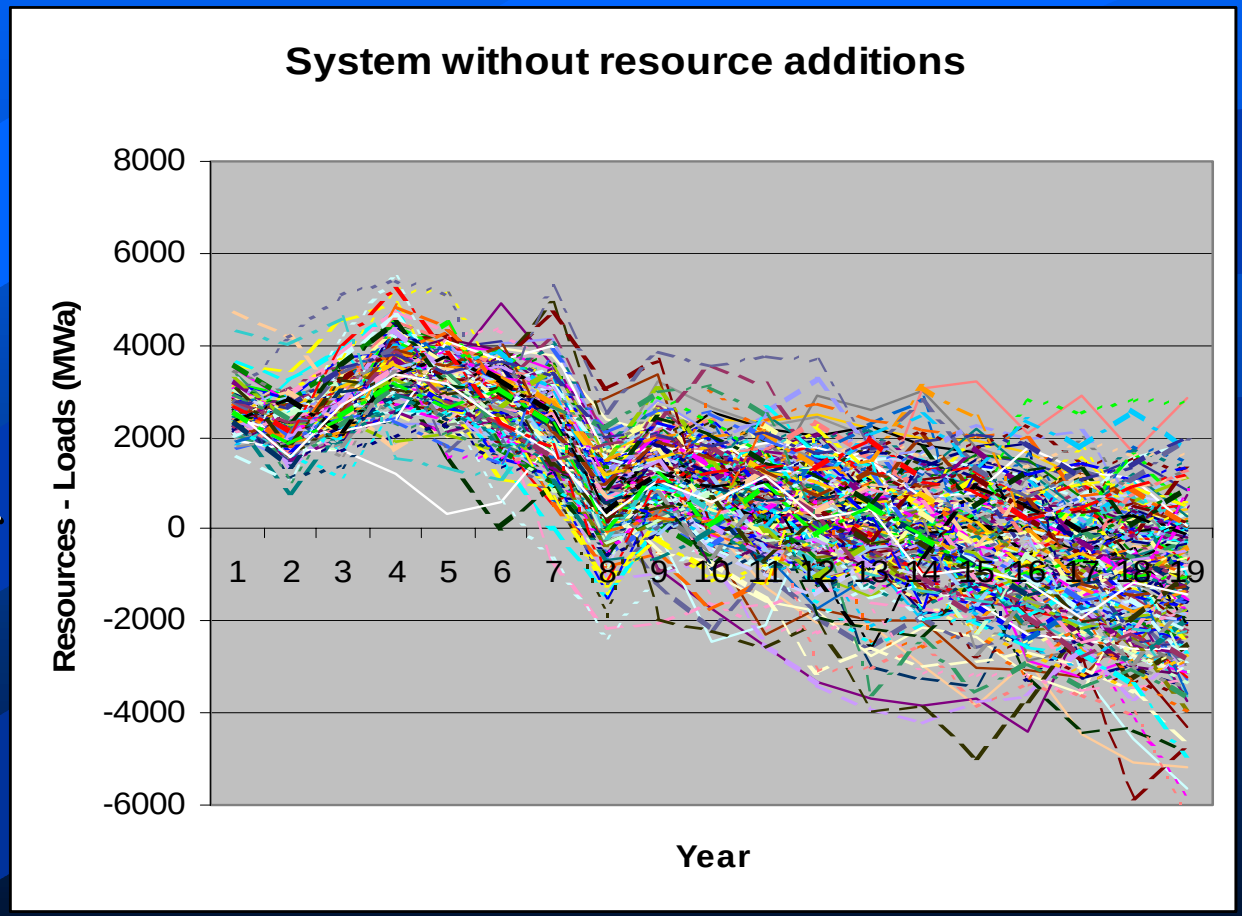
Reserve Margin

- Reserve Margin Across the first 200 futures



Reserve Margin Without Additions

- Market-driven conservation
- No resource additions
- 2500 MW of DR by 2023



Loss of Load Probability

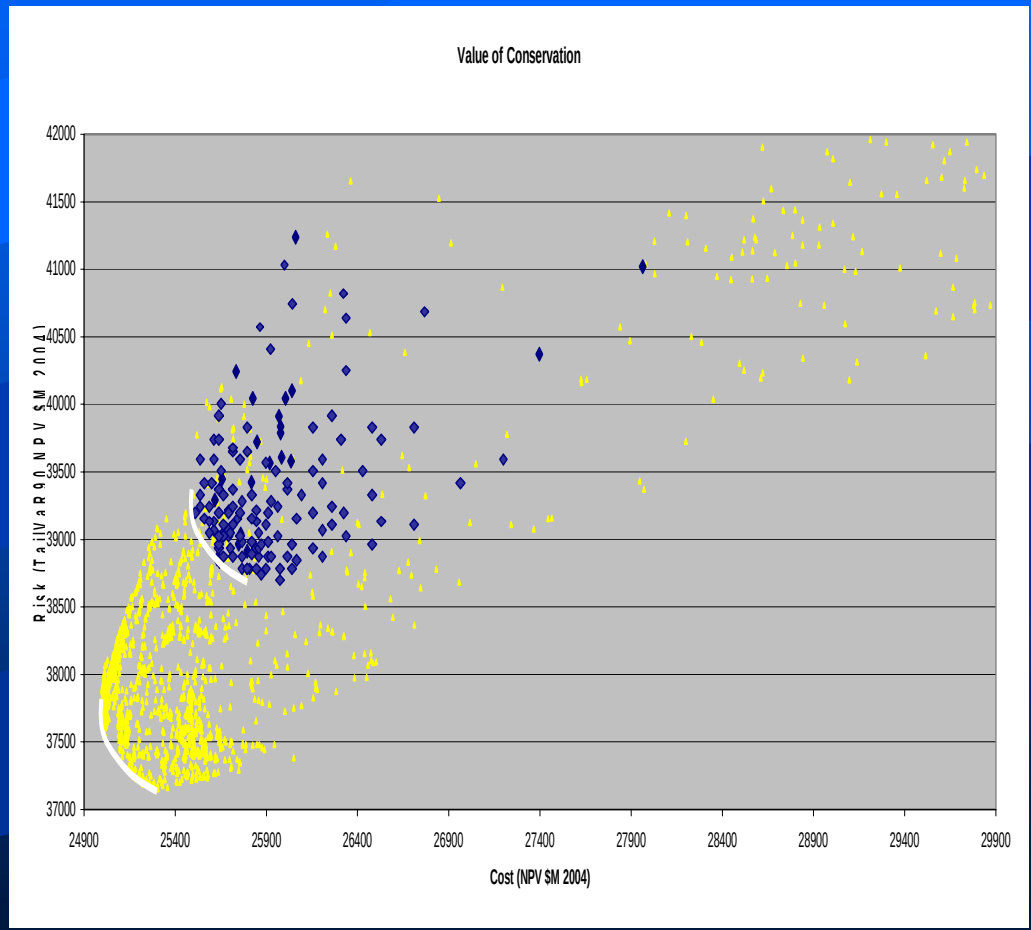
- Used Genesys to evaluate the plan we have been looking at
- Assumed completion of construction according to minimum construction cycle requirements
- Using the 10 MW-season threshold criterion, the LOLP is
  - 2008, 2010: Less than 4 percent
  - 2013, 2018, 2023: Less than 2 percent
- We have deemed LOLP under 5 percent satisfactory in prior studies

Valuation of Resources

- Demand Response
  - From our prior evaluation, we expect demand response potentially could reduce cost by $150 M and TailVaR90 risk by $700 M NPV (2004$)
- Conservation
- Renewables

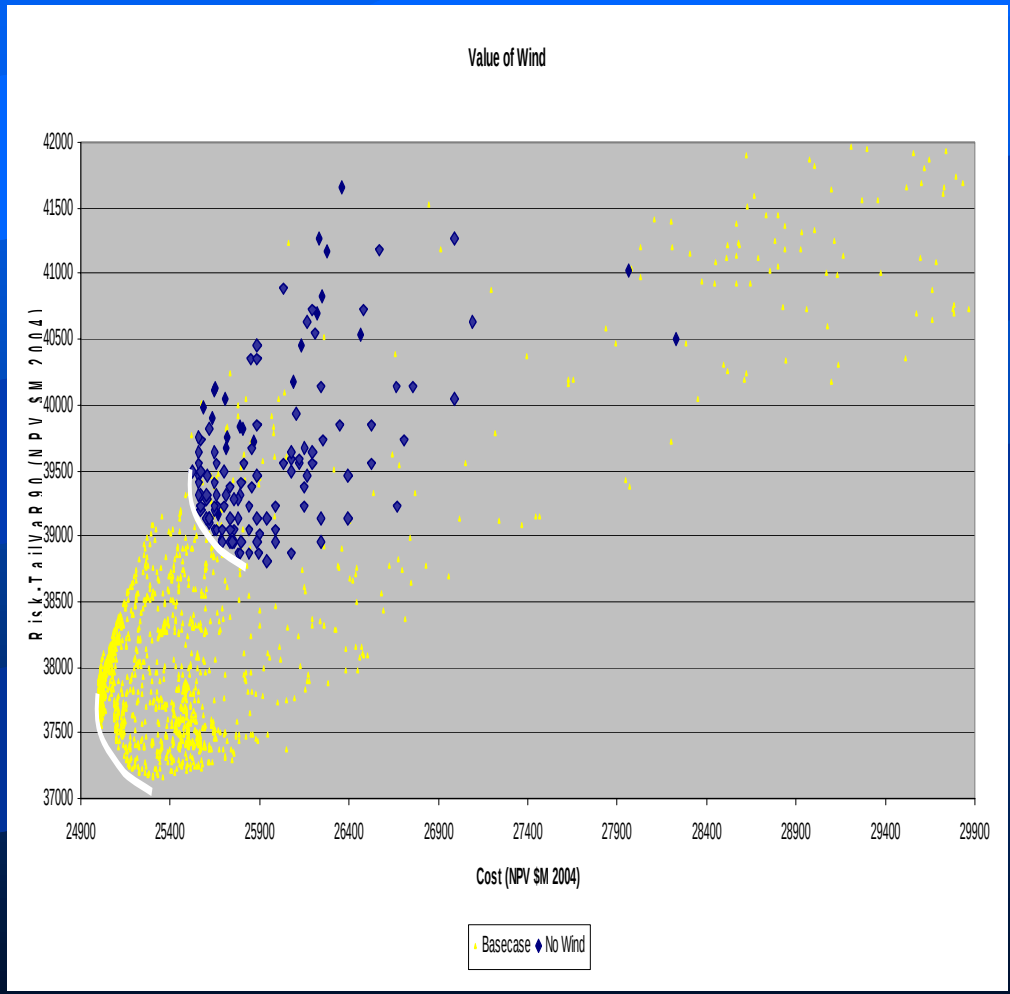
Valuation of Conservation

- The NPV 2004 cost of the policy of letting conservation be driven entirely by the market is about $500 M
- The impact on risk is much greater, about $1.5 B



Valuation of Wind

- The NPV 2004 cost and risk impacts of the policy of excluding wind as an option are about the same as those for conservation.



Conclusions

- Our Action Plan seems to be holding
  - No resource additions before June 2013 appear to be necessary
  - A sustained level of conservation development reduces cost and risk
  - Demand response warrants better understanding
  - We need to evaluate the role of transmission for resources that will be completed starting 2013

End

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