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Michigan Public Service Commission Integrated Resource Planning Stakeholder Group Meeting

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August 8, 2017

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Today's Agenda

Time	Content
9:00 – 10:00 am	Review of IRP content and development process • Focus on treatment of efficiency and demand response
10:00 – 11:00 am	Time-varying value of energy efficiency research
11:00 - Noon	**Uncertainty and Risk Analysis**
Noon – 1:30 pm	Lunch break
1:30 – 3:30	Stakeholder engagement

Session 3 - Uncertainty and Risk
Managing the Unknown

As we know,

There are known knowns.

There are things we know we know.

We also know

There are known unknowns.

That is to say

We know there are some things

We do not know.

But there are also unknown unknowns,

The ones we don't know

We don't know.

Donald Rumsfeld. Feb. 12, 2002, Department *of Defense news briefing*

Key Risk Analysis Questions

- What are the vulnerabilities of your plan?
- How do you expect uncontrollable factors to influence each other? In the short term? In the long term?
- Could new regulation, market conditions, or technological innovation change these relationships?
- What are the key drivers of risk? What would force you to change your plan? What are the threshold events and values that trigger alternative plans?
- Where is the perfect foresight assumption hiding?
- How much would it cost to change the plan? ("Type I" and "Type II" error costs.) What is your "exit strategy?"
- Which sources of uncertainty can be aggregated? (e.g., electricity price and technology innovation)
- What is the appropriate application of quantitative methods?

Perfect Foresight is Not Possible

Heisenberg

$$\Delta x \Delta \rho \geq \frac{\hbar}{2}$$

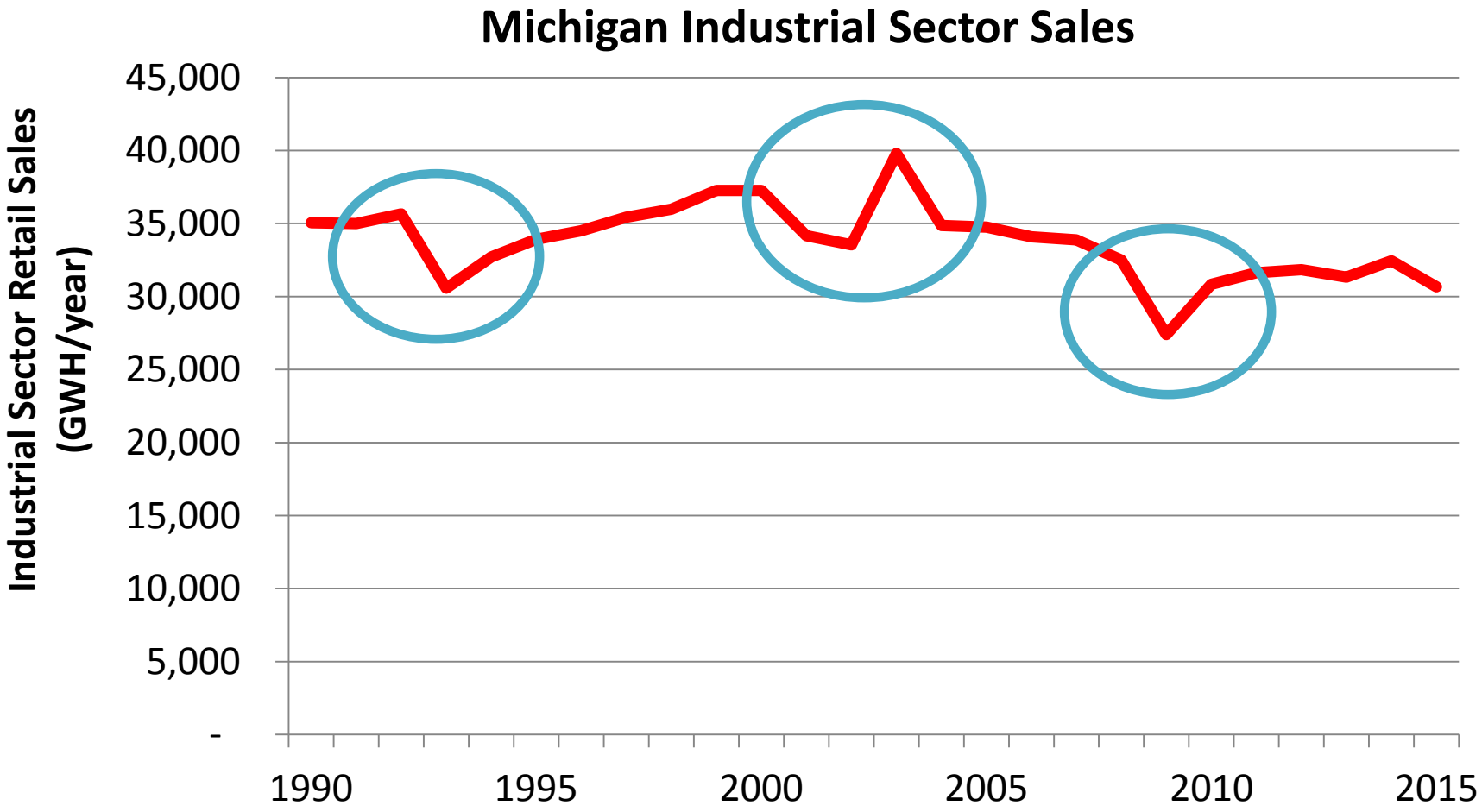
have been here.

But All IRP's Require Assumptions About the Future

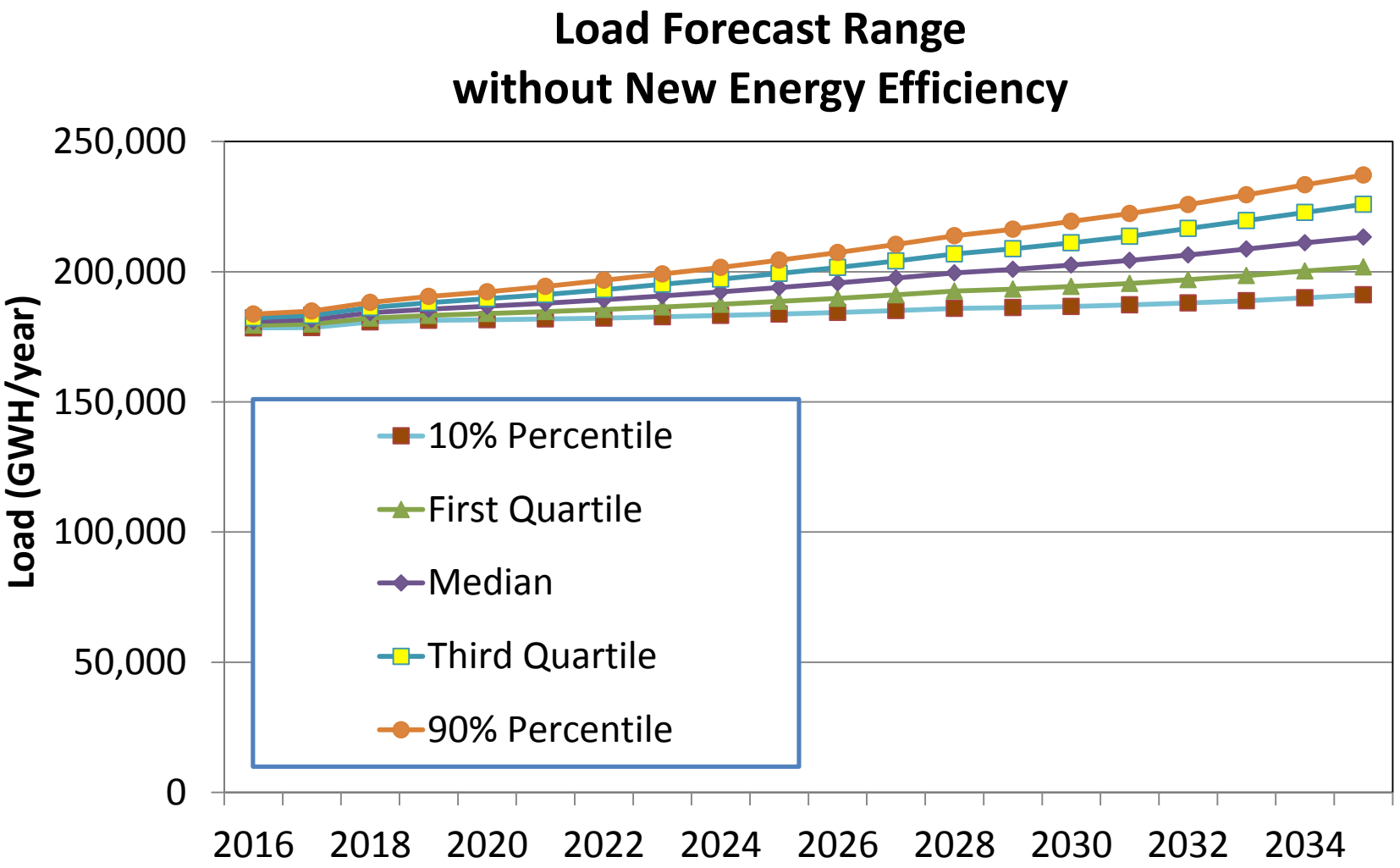
IRPs Must Address Three Major Sources of Uncertainty

- Load Uncertainty
- Resource Uncertainty
  - Output
  - Cost
  - Construction Lead Times
  - Technology Change
- Wholesale Electricity Market Price Uncertainty

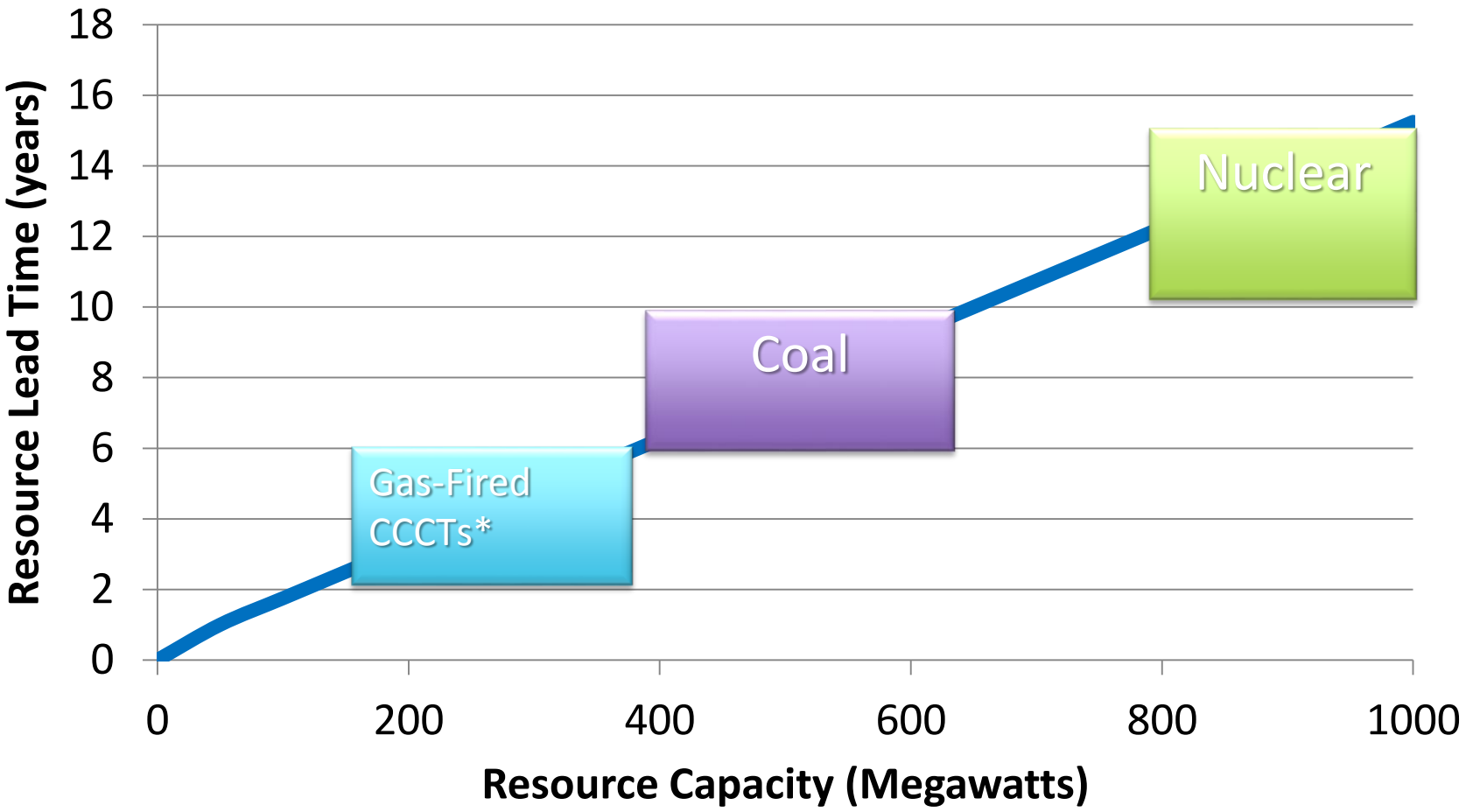
Historical Levels of Load Uncertainty in Michigan Were Driven by Large Industrial Loads



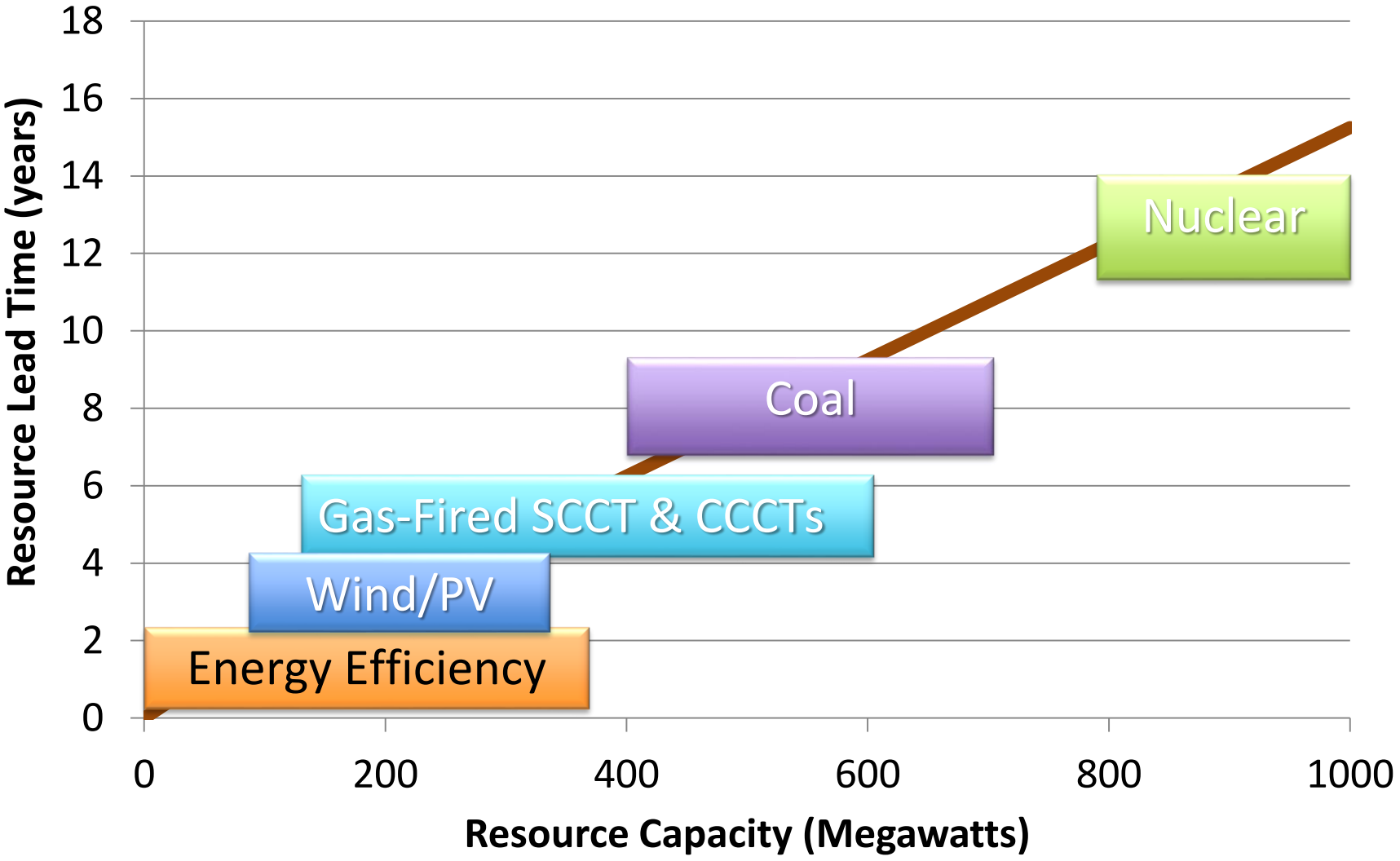
Best Practice Load Forecasts for IRPs Do Not Assume *Perfect Foresight*



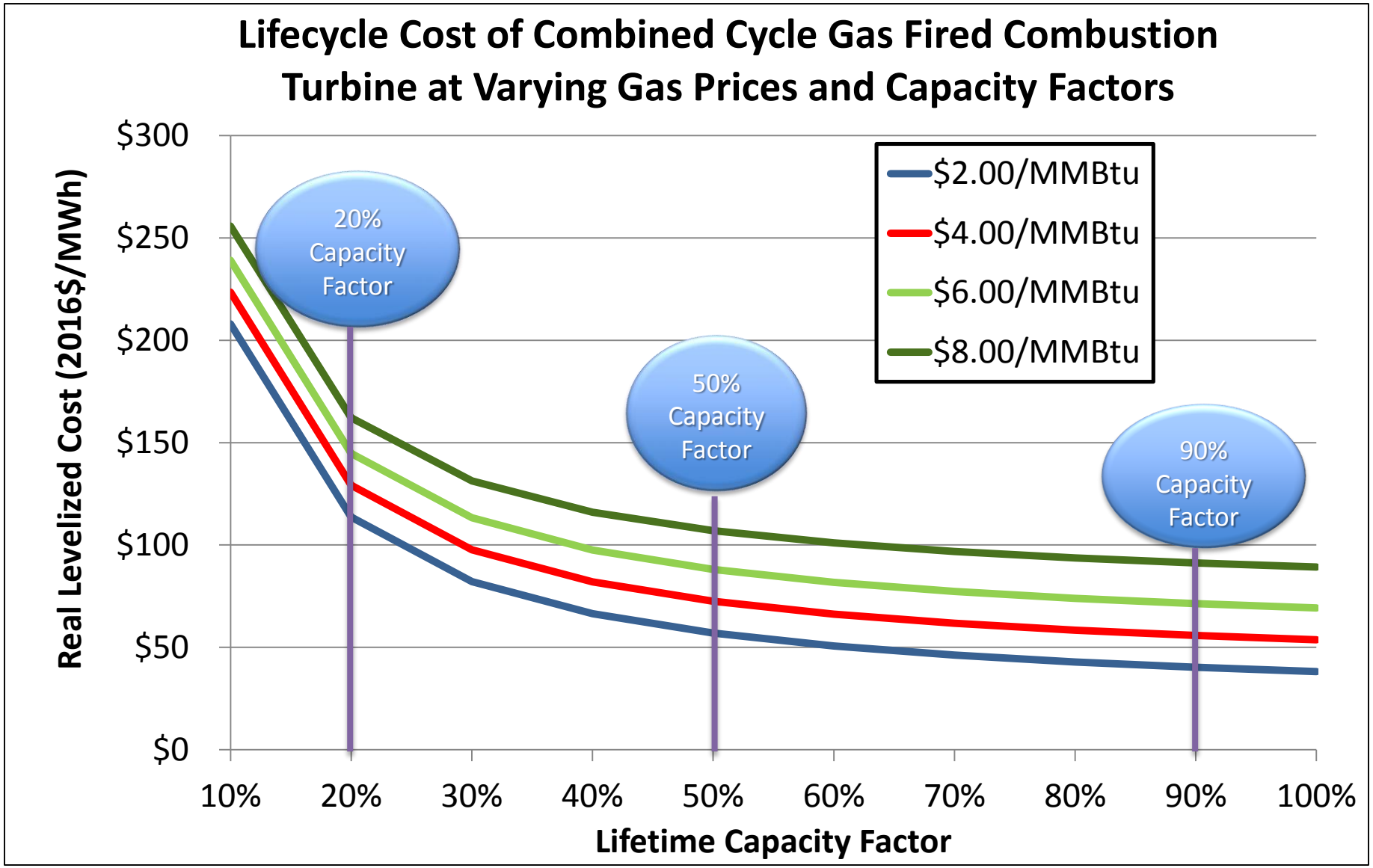
Load Uncertainty Is Particularly A Problem For Resources With Long Lead Times and Large Sizes



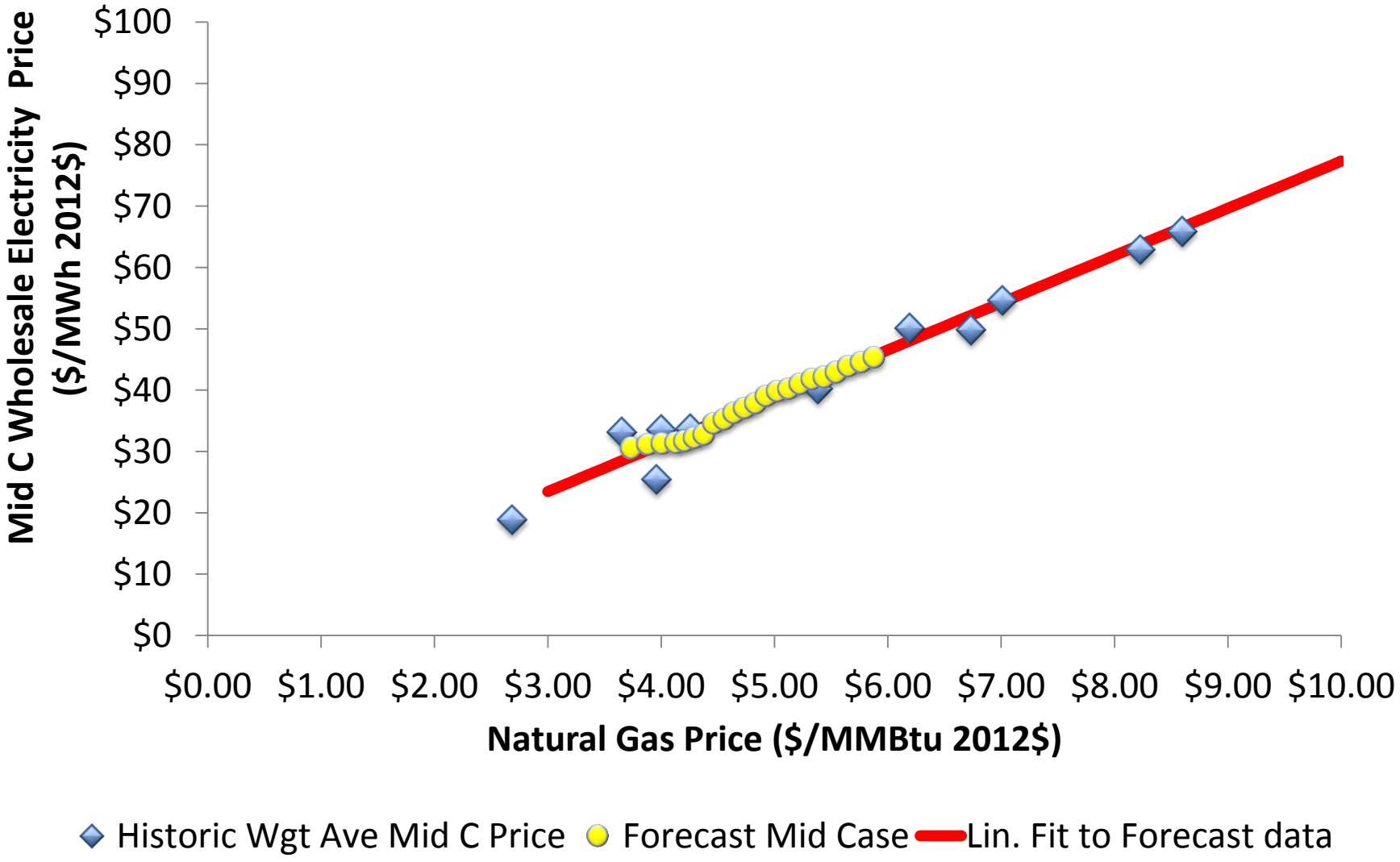
Energy Efficiency, Demand Response and Shortened Lead Times and Smaller Sizes For Some Generating Resources Reduce Exposure to Load Uncertainty



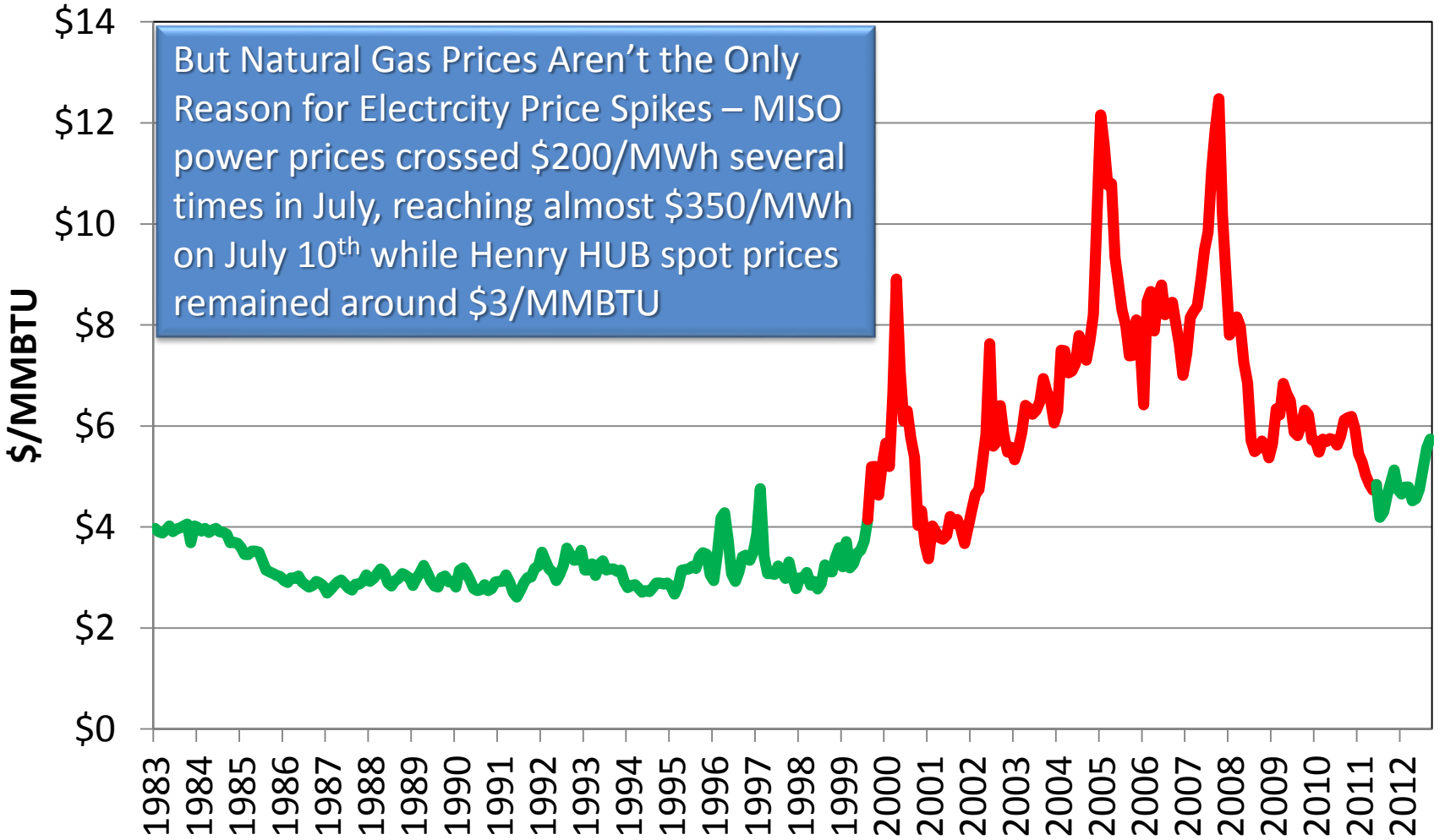
Generating Resource Cost Uncertainty Is Primarily Driven by Input Fuel Prices and Utilization (i.e., "capacity factors")



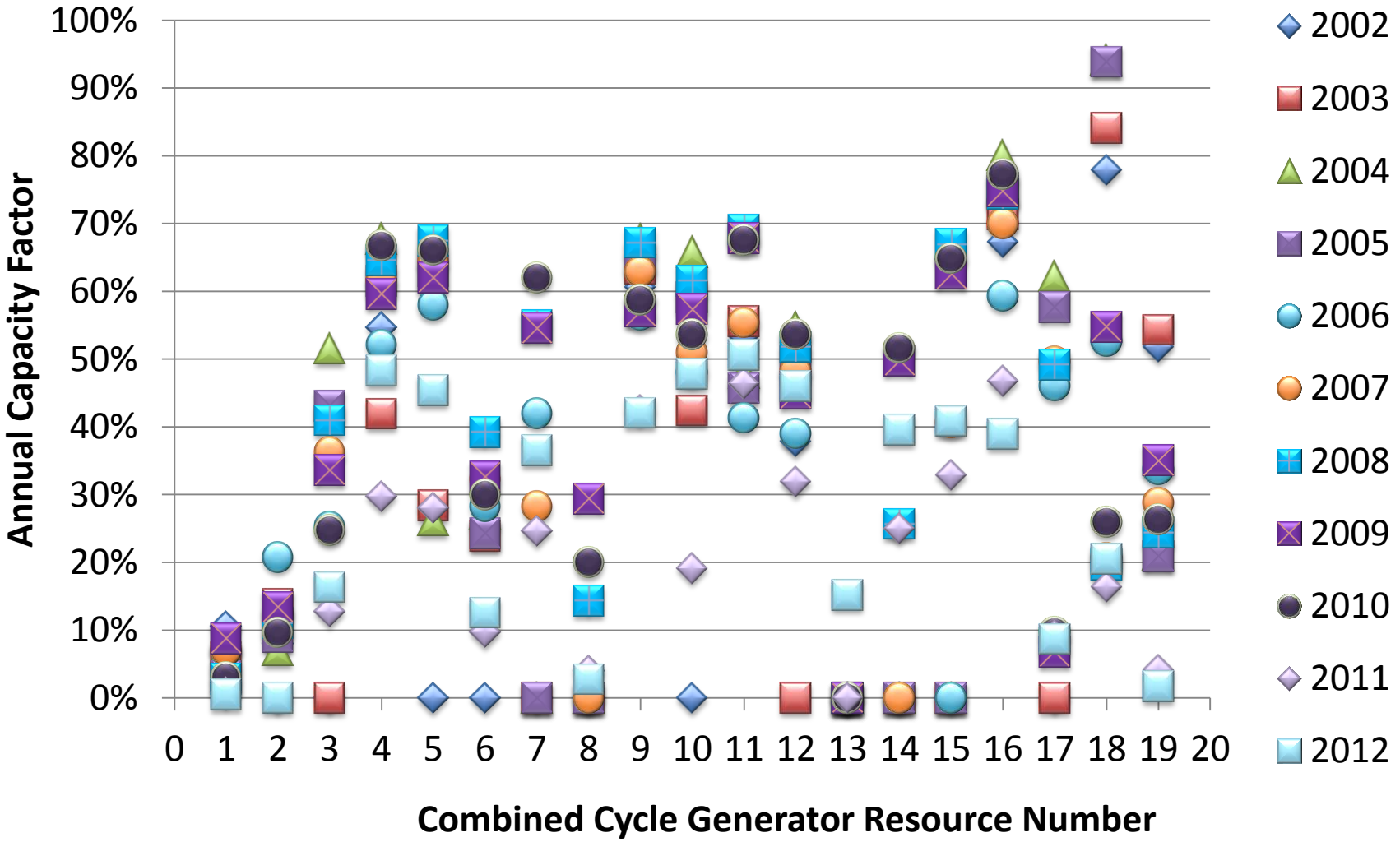
Wholesale Electricity Market Prices Are Strongly Correlated to Natural Gas Prices



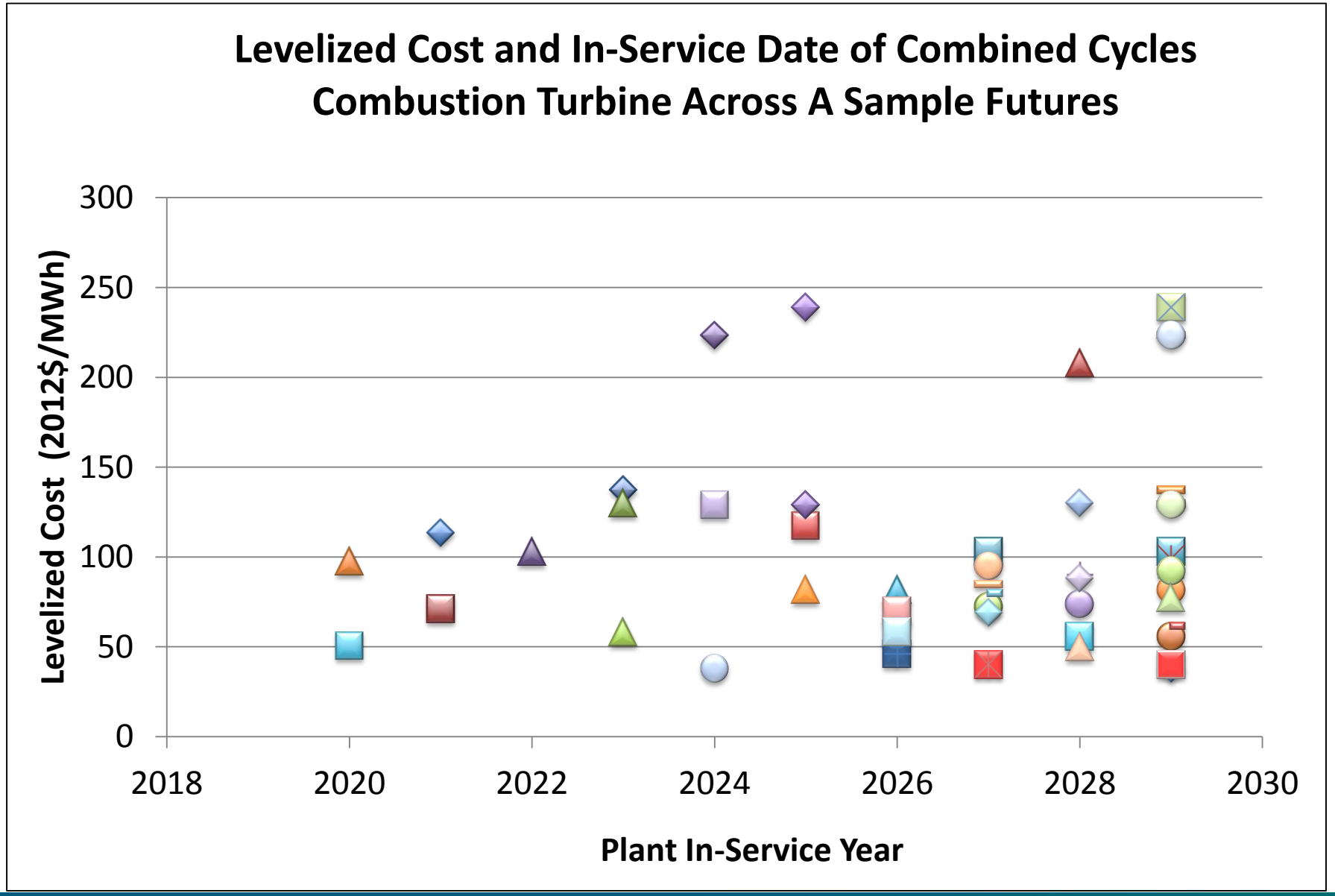
When Natural Gas Market Prices Provide *Surprises*, They Pass Along That *Gift* To Wholesale Electricity Prices



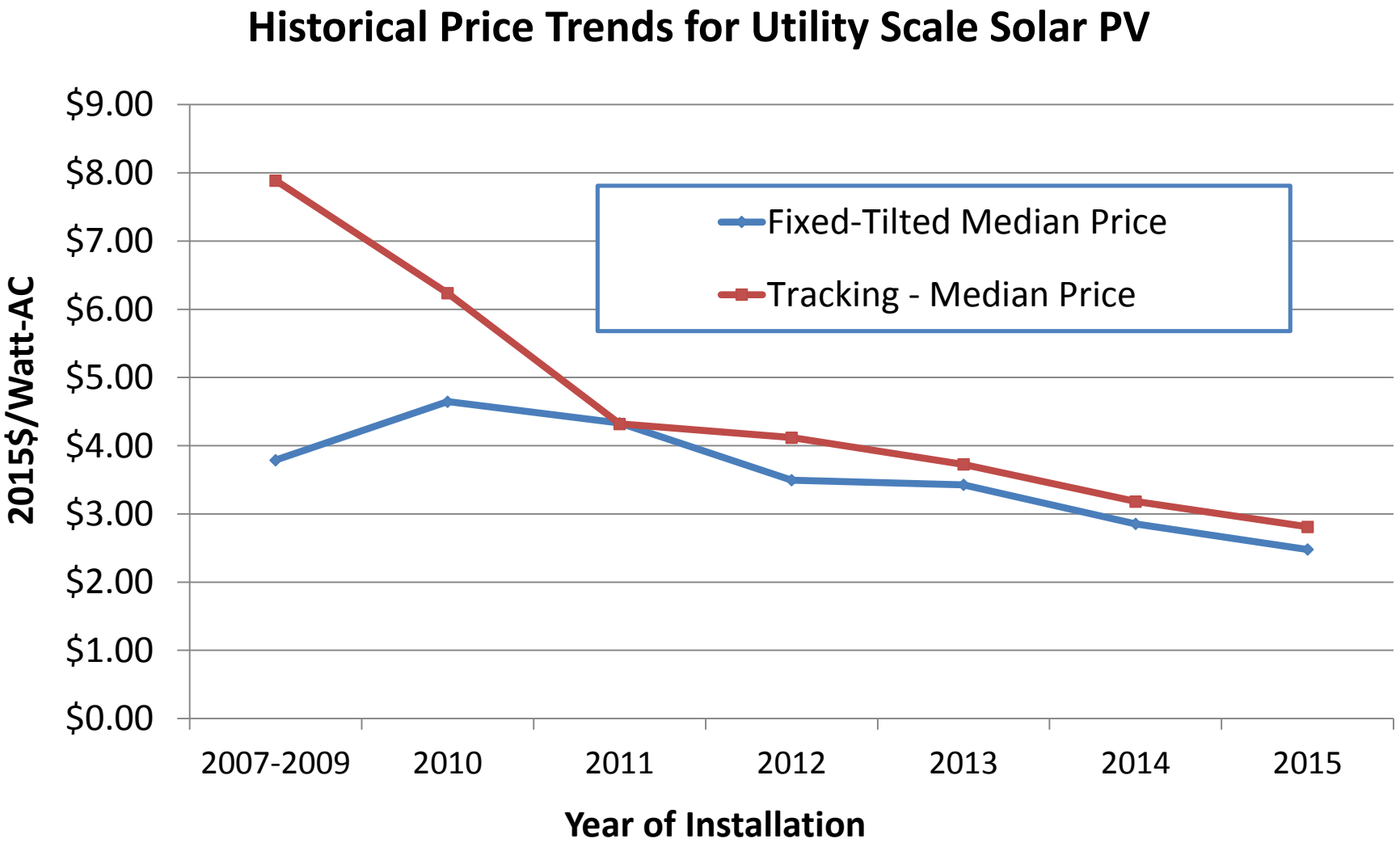
Combined Cycle Generation Resource Capacity Factors Can Vary Significantly From Year-to-Year



These Uncertainties Mean There's No Single "Avoided Cost" for New Resources – Hence No Single Avoided Cost for Energy Efficiency (or Demand Response)

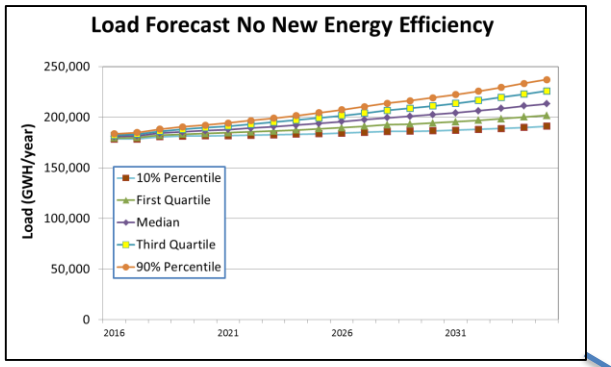


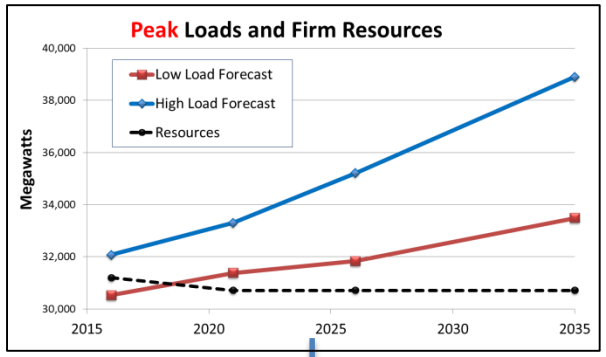
The Pace of Technology Change Introduces Additional Uncertainty Into the Determination of Avoided Cost

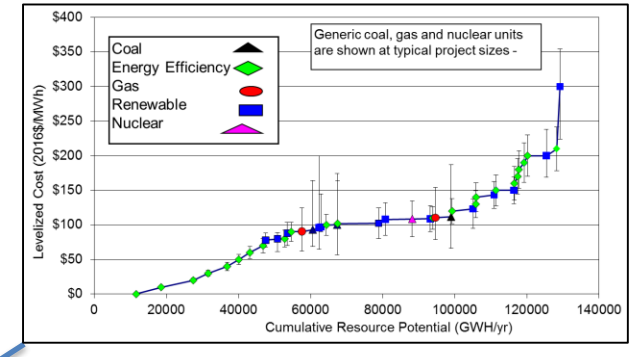


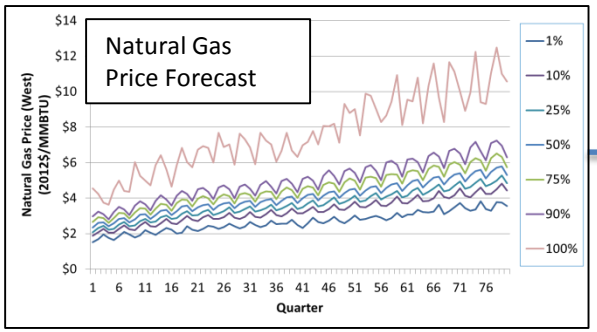
Source: LBNL

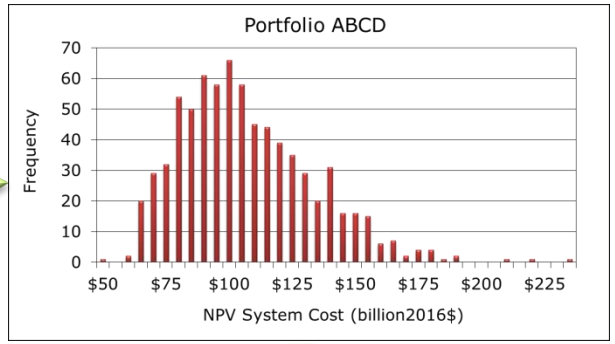
Best Practices IRPs Use Scenario Analysis "Stress Test" Resource Strategies Across A Range of Future Conditions

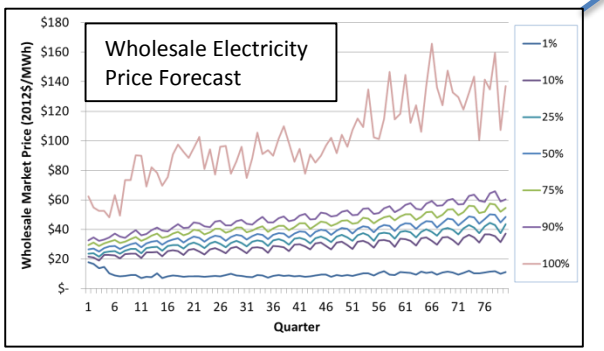


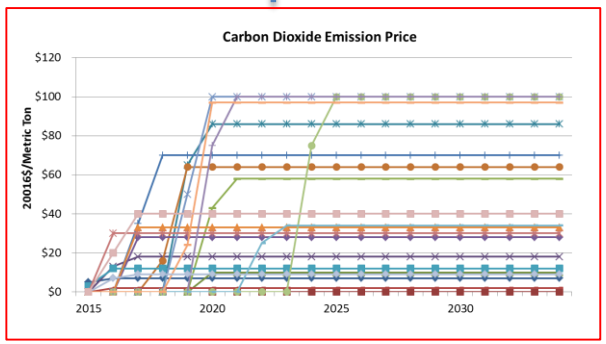


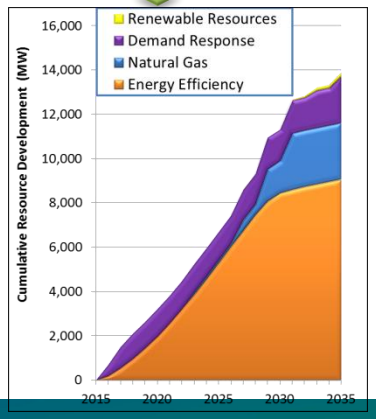








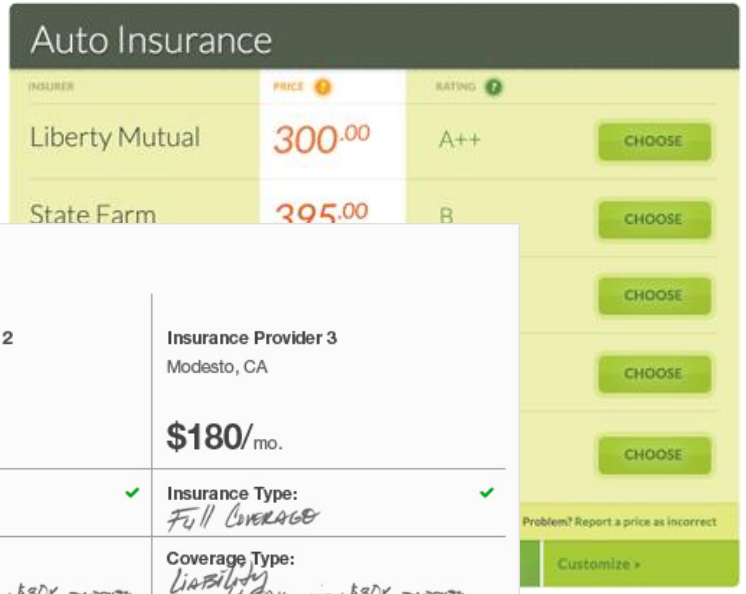


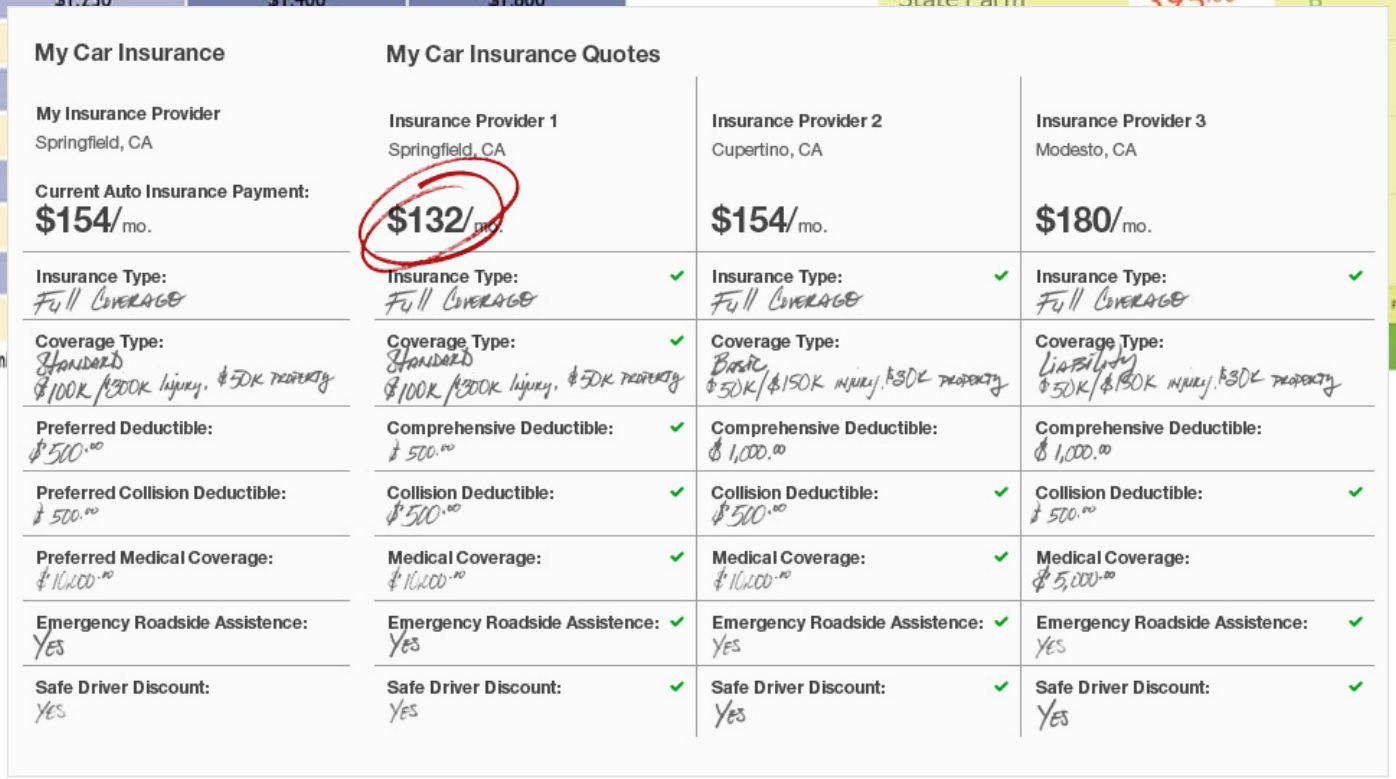


The "Optimization Objective" of Best Practice IRPs - Find the Lowest Cost "Insurance" for the Same Risk Coverage

	LOW DEDUCTIBLE	MIDRANGE DEDUCTIBLE	HIGHER DEDUCTIBLE
Policy year claim is filed	$250 deductible $1,000 premium	$500 deductible $900 premium	$1,000 deductible $800 premium
1	$1,250	$1,400	$1,800
2			
3			
4			
5			
6			
7			
8			

Source: CR Money Lab. Prem





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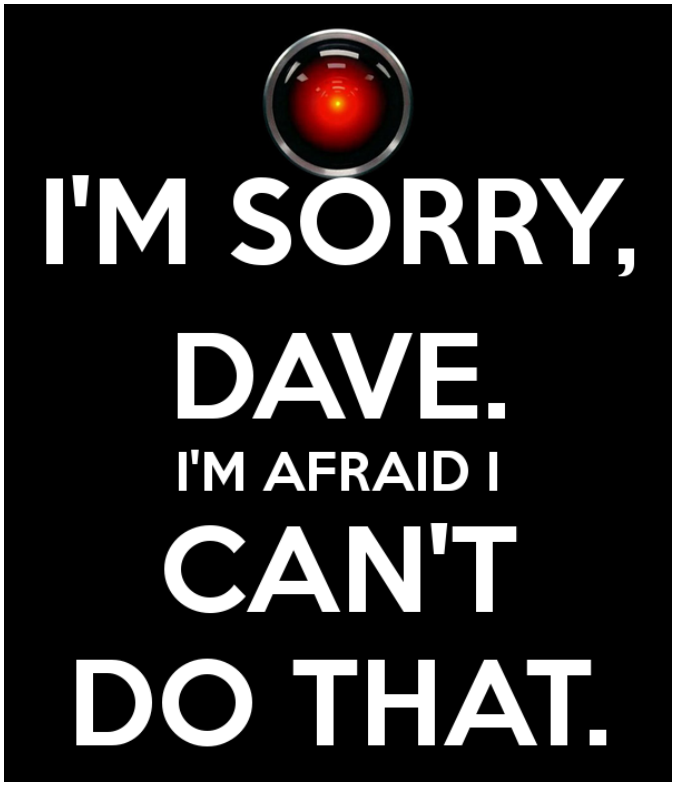
Most Capacity Expansion Models Are Not Designed to Conduct Risk Analysis

- Market equilibrium models generally optimize capacity expansion for a single future (i.e., they have perfect foresight)
- Sensitivity studies can inform risk analysis, but still compare optimizations done for single futures



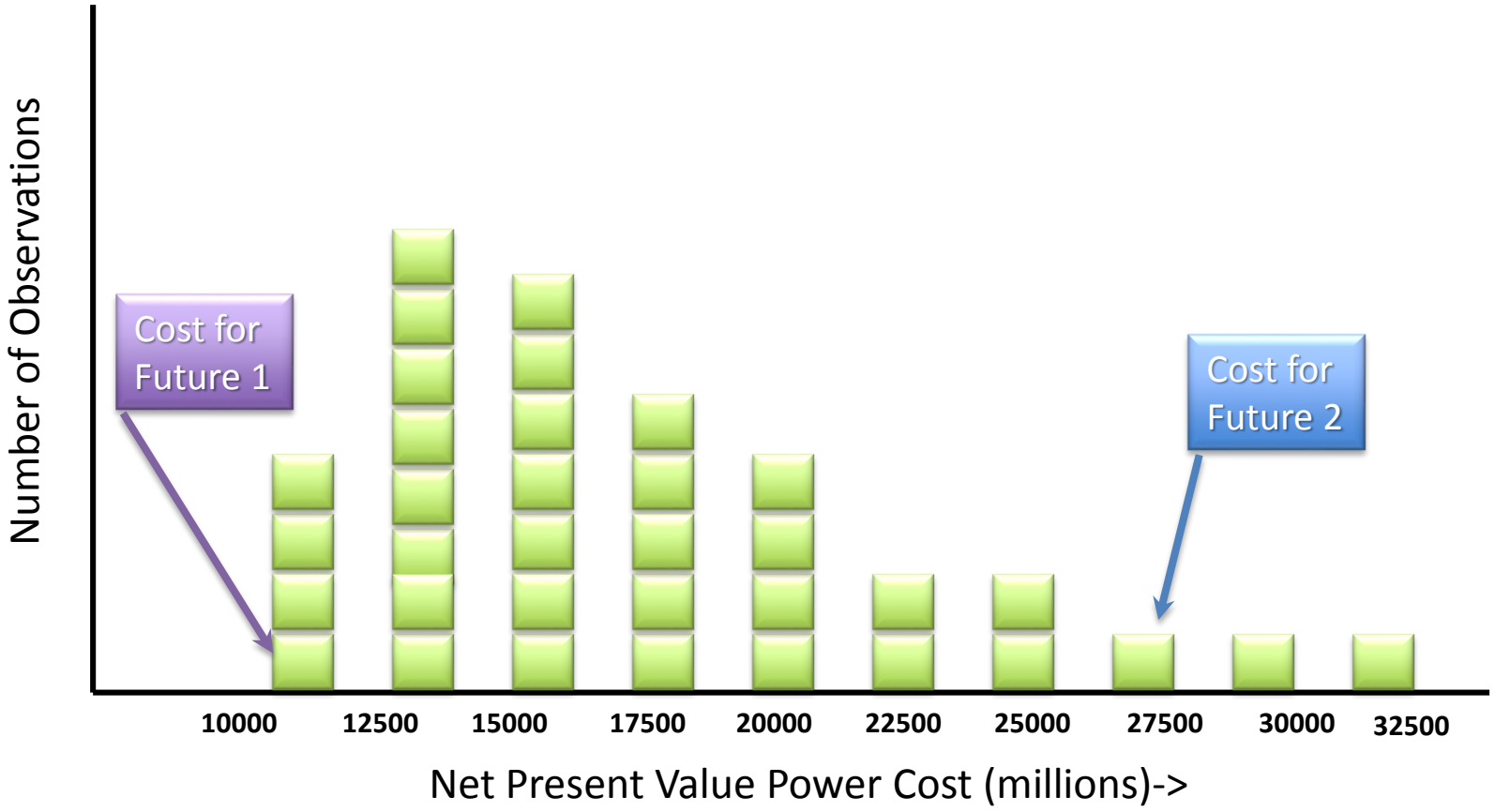
What Does Stochastic Risk Analysis Model Do?

- It test *thousands* of alternative resource strategies (those things we control)
  - Varying the amount and timing of resource development
    - Energy Efficiency (retrofit, lost-opportunity)
    - Demand Response
    - Natural gas fired CCCT and SCCT
    - Wind and Utility Scale Solar
  - Varying the amount and timing market purchases in lieu of resource development
- Against *hundreds* of different futures (those things we don't control)
  - Fuel price Uncertainty
  - Carbon risk Uncertainty
  - Load Uncertainty
  - Resource Uncertainty
  - Technology Change Uncertainty
  - Wholesale Market Price Uncertainty
- It "sorts" through all of the resource strategies to find those with the *lowest cost for each level of risk.*

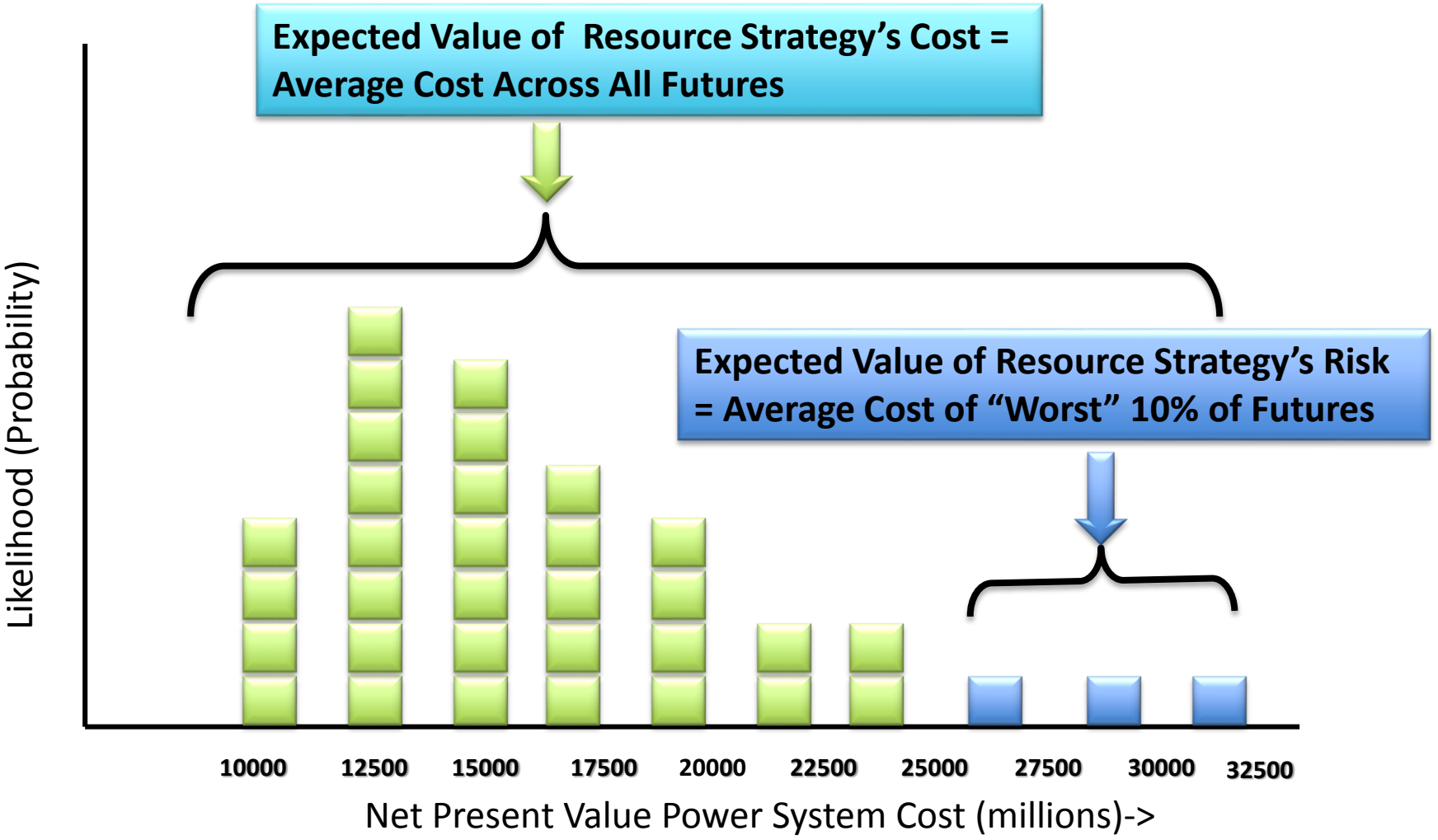
How the Strategic Risk Analysis Approach Differs

- Likelihood analysis that captures *strategic uncertainty*
- *Imperfect foresight* and use of decision criteria for capacity additions
- *Adaptive plans* that respond to futures
- "Scenario analysis on steroids"
  - Hundreds of futures, strategic uncertainty
  - Frequency that corresponds to likelihood

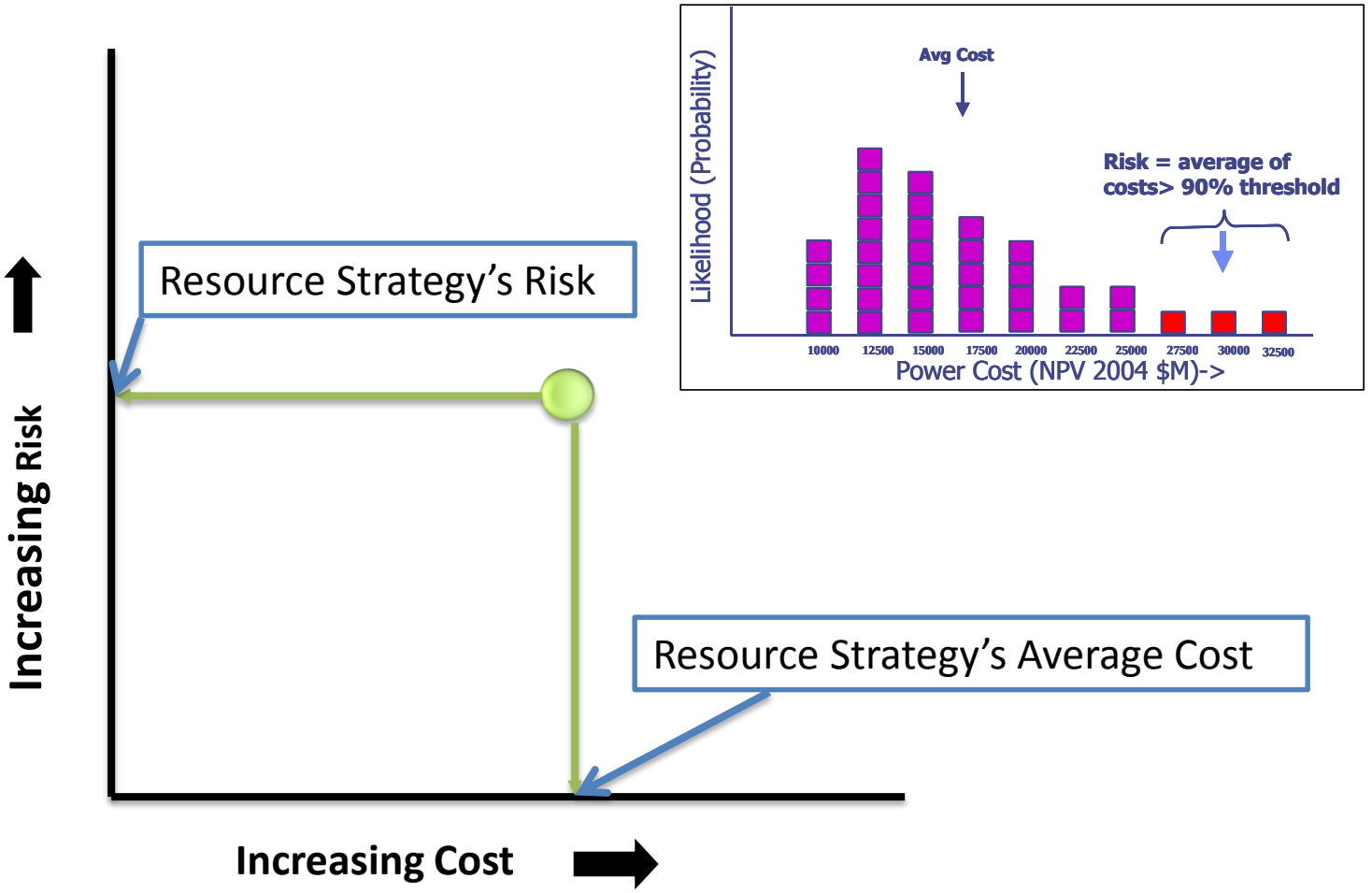
A Resource Strategy's Cost and Risk Depend on the Future



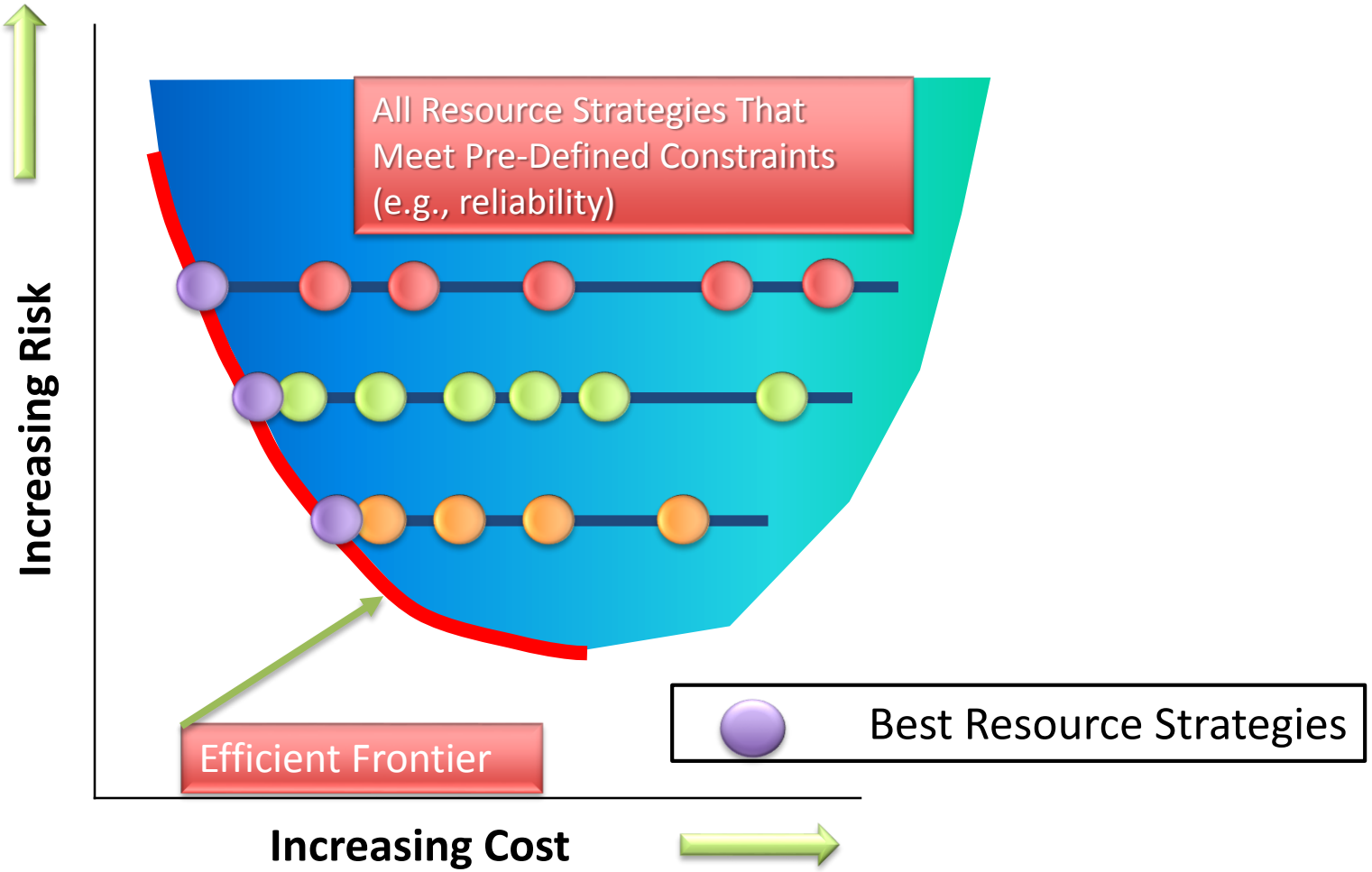
Expected Cost and Risk Metrics Are Used to Characterize Each Resource Strategy



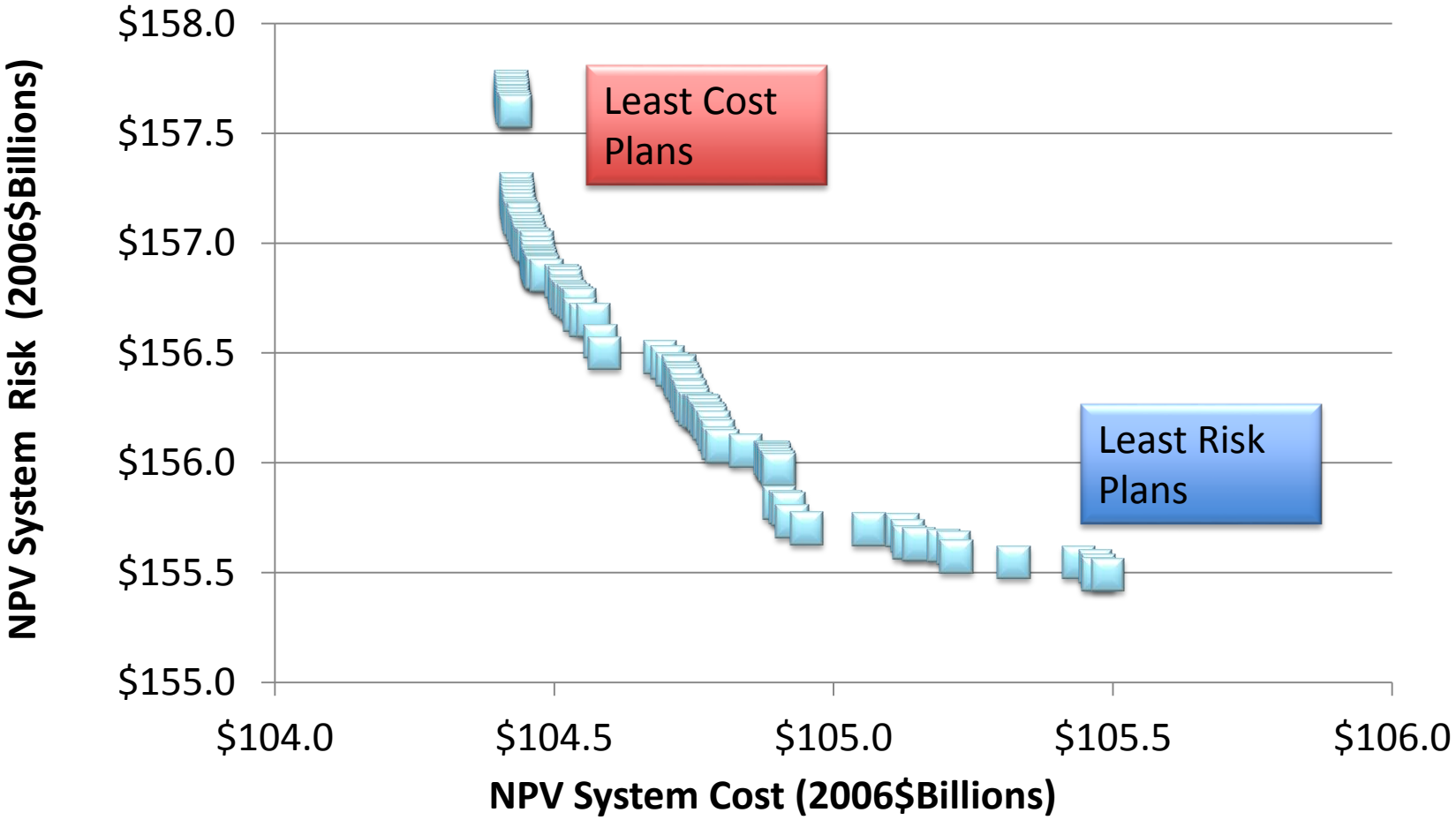
Risk Analysis Models Are Use These Metrics To Select the Resource Strategies with the Lowest Expected Cost for Varying Levels of Risk



The "Best" (i.e. Lowest Cost) Resource Strategies at Each Risk Level Form the *Efficient Frontier*



The Efficient Frontier Permits Policy Choices Regarding the Cost of Insuring Against Risk



What does the Efficient Frontier Tell Us?

- The Efficient Frontier does ***not*** tell us what to do
- The Efficient Frontier tells us what ***not*** to do
- Most useful if there are a large number of choices

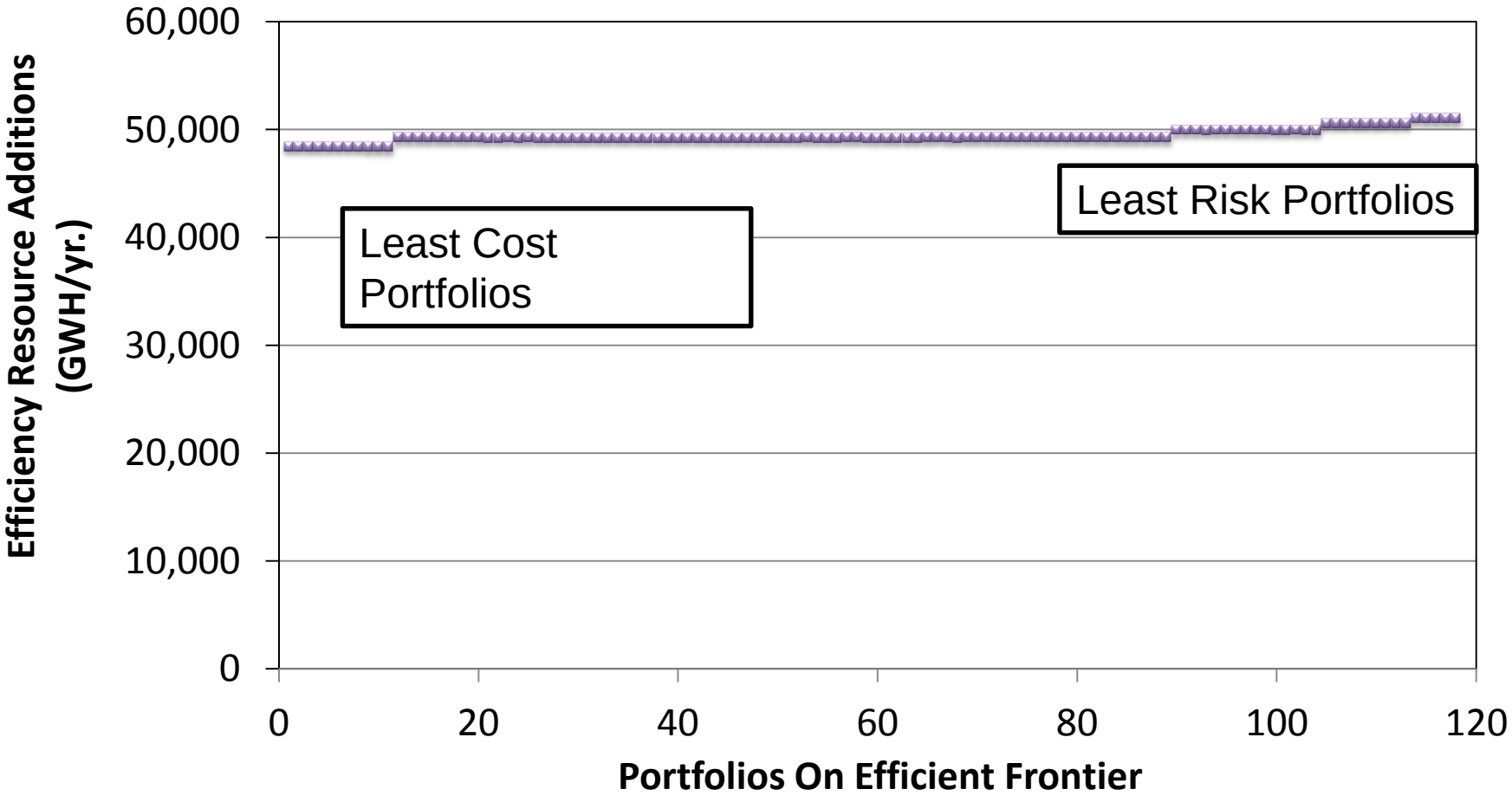
What Can We Learn from Exploring the Efficient Frontier

- What are the similarities among strategies close to the efficient frontier?
- How do strategies change as we move along the efficient frontier?
- What are the similarities among strategies removed from the efficient frontier?
  - Relationships among plans on, off, and over the efficient frontier can provide insight into what are more and less successful strategies
- How do plans differ with respect to other sources of risk?
- How do details *within* particular futures differ?
- When do you really have to make a choice?
- What costs and elements can you control?

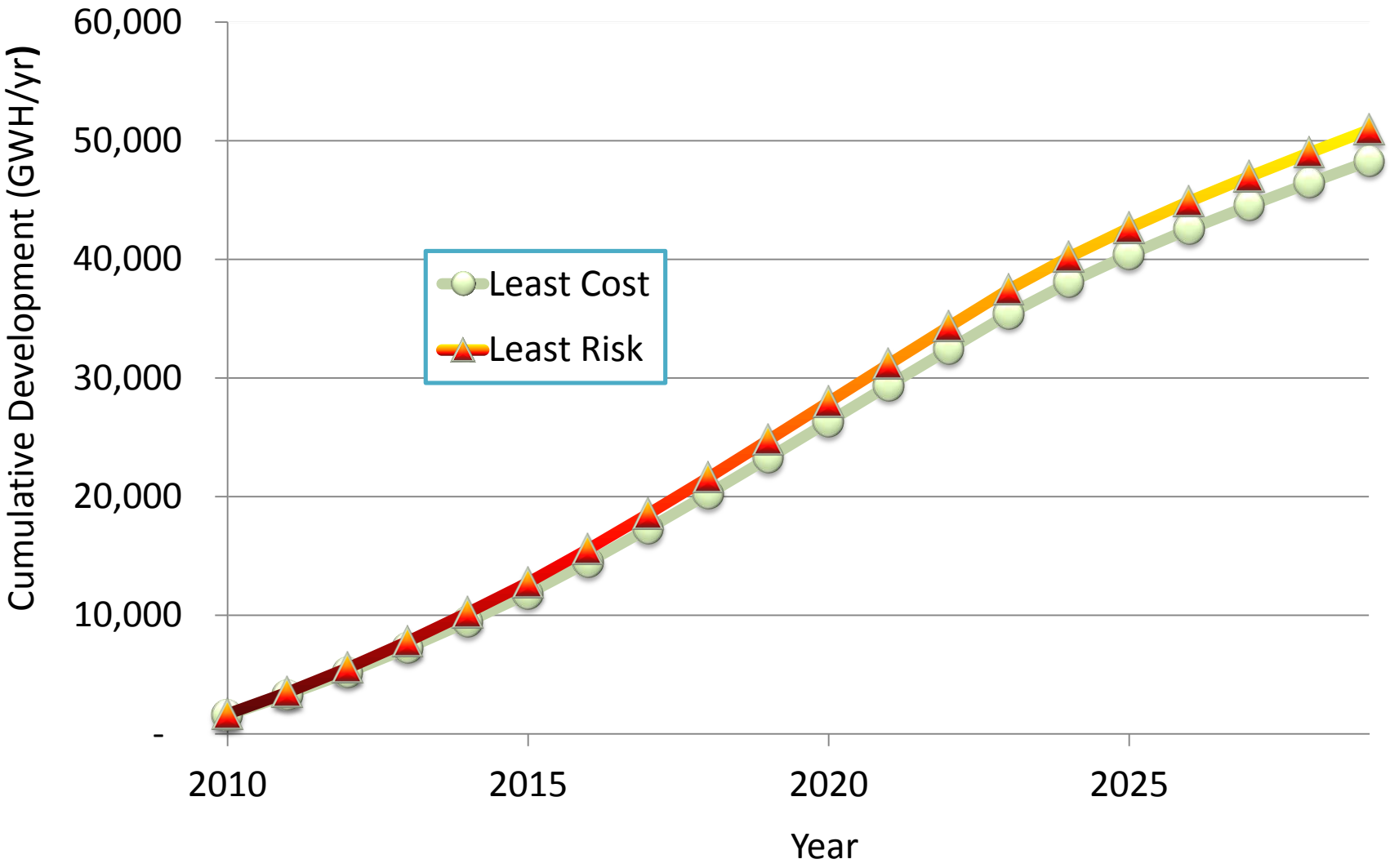
Lessons Learned from Exploring the "Efficient Frontier"

- Power plant construction lead time is major source of economic risk
- It is better to be a little surplus in resources than a little deficit, but…
  - The biggest blunder is overbuilding
- Not all resources can or should recover their cost in the wholesale electricity market
  - Specifically, acquiring EE at levelized cost above short-run market prices reduces both cost and risk
- Low Cost resource portfolios rely more heavily on the wholesale market purchases, while Low Risk resource portfolios build additional resources
- Energy Efficiency is a Lower Cost and Lower Risk Source of Reserves Than Natural Gas Generation
- Hedges and Options can be used to manage risk

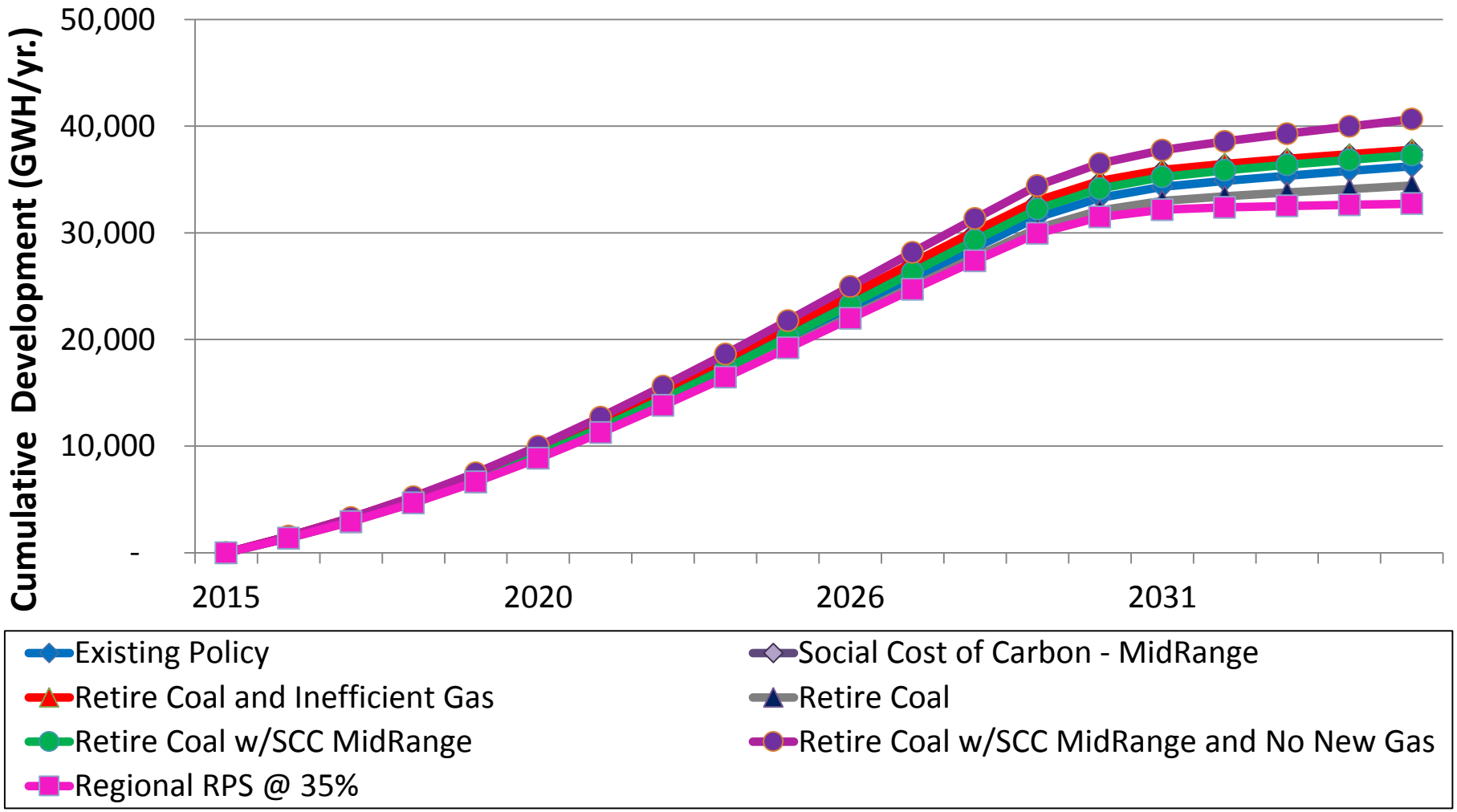
The Least Cost and Least Risk Resource Portfolios Both Rely Heavily on Energy Efficiency



The Near-Term Pace of Energy Efficiency Development Does Not Vary Significantly Between Least Cost and Least Risk Portfolios

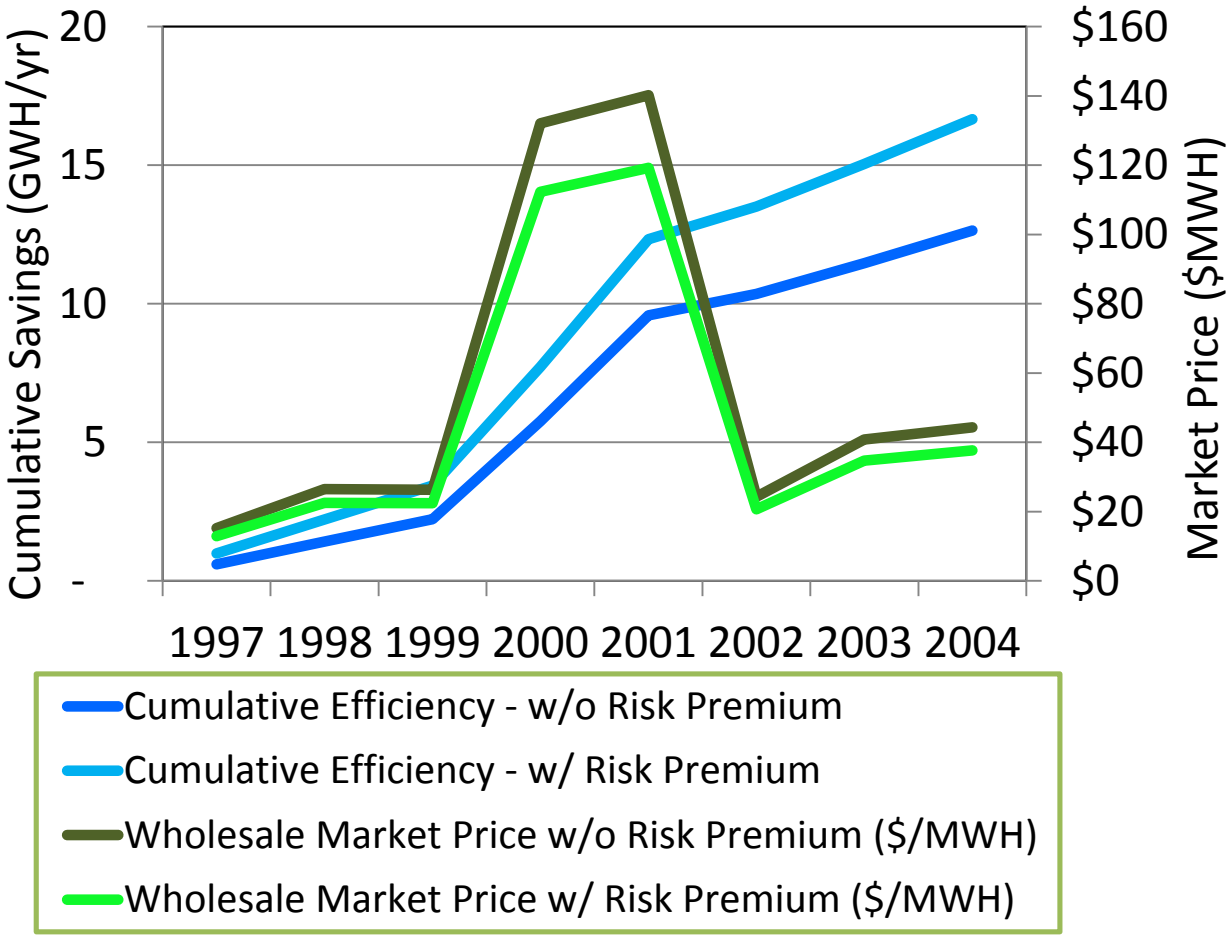


The Near-Term Pace of Energy Efficiency Development Does Not Vary Significantly Across A Wide Range of Policy Assumptions



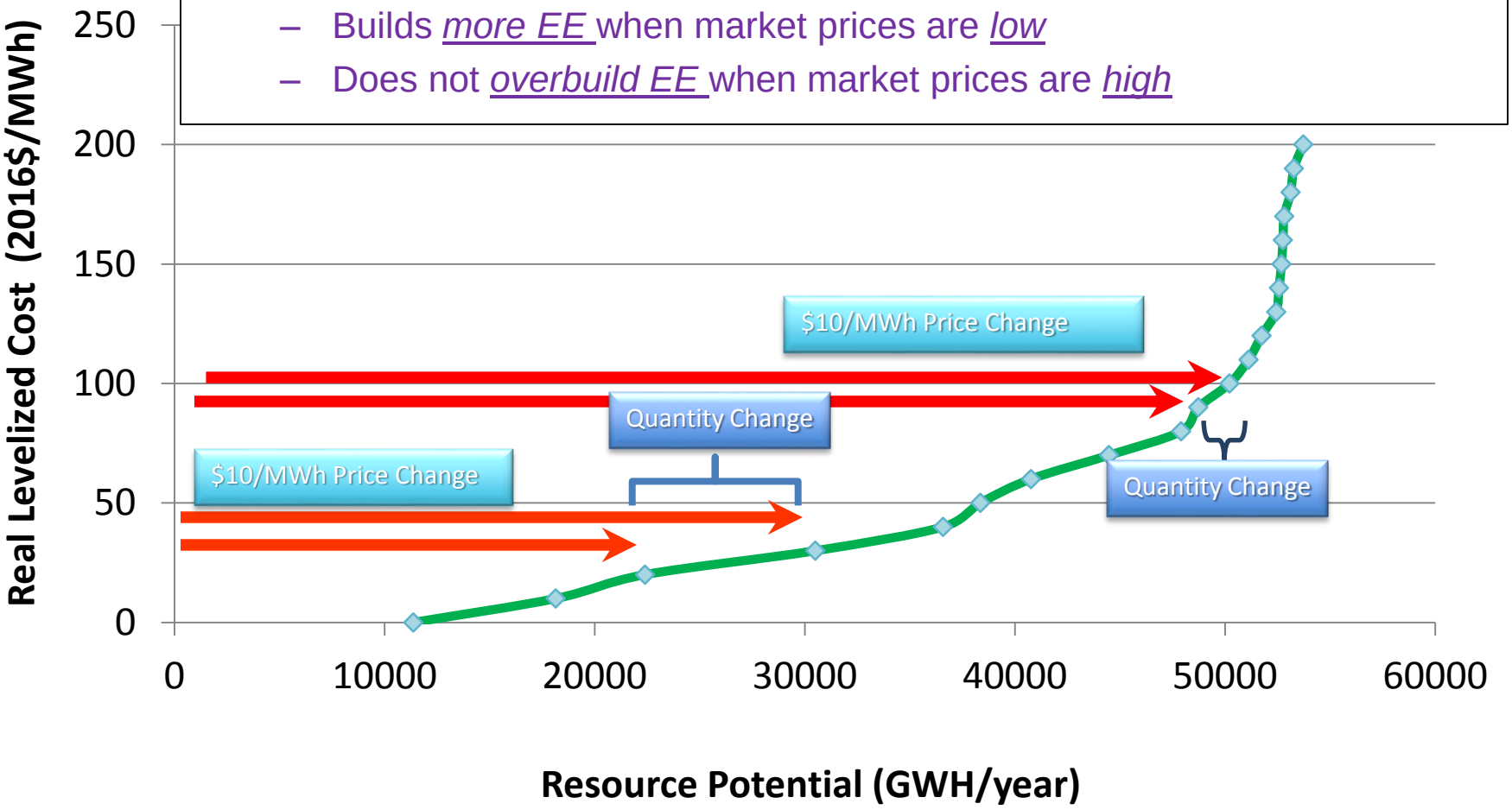
Energy Efficiency Is an Inexpensive Source of *Reserve Margin*, Which Reduces Market Exposure Risk & May Moderate Wholesale Price Swings

- Efficiency's value stems from "*being there*" when a shortage hits (high prices)
- Higher levels of efficiency (lower demands) provide more price moderation

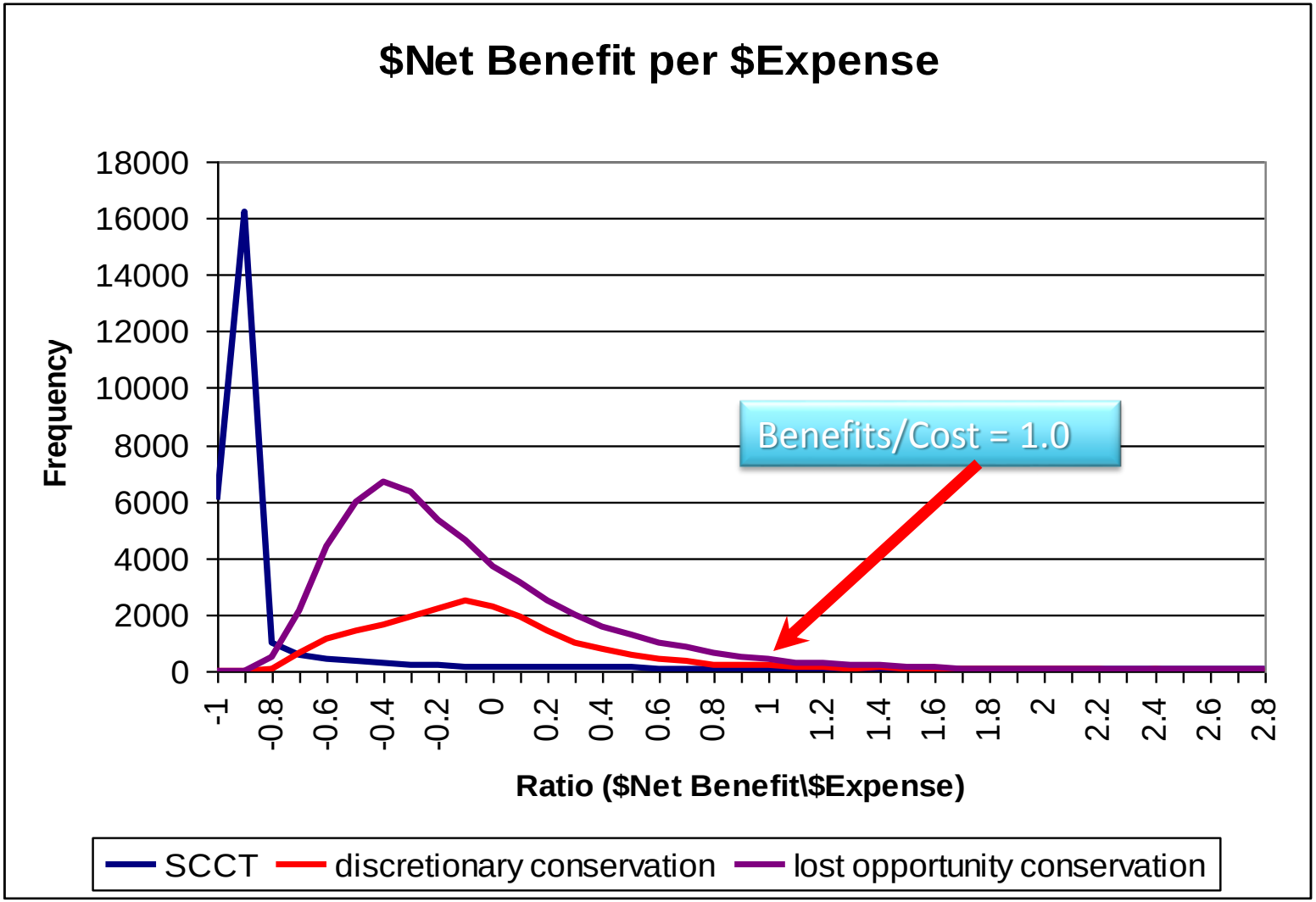


Energy Efficiency's Non-Linear Supply Curve Has Implications for Its Risk Mitigation Value

- EE Supply Curve Exhibits "Diminishing Returns"
- Acquiring EE *At A Premium* over Short Term Market Prices
  - Builds *more EE* when market prices are *low*
  - Does not *overbuild EE* when market prices are *high*



Why Is EE A Lower Cost Way of Providing Reserves? Energy Efficiency Has Value Even In Low Market Price Conditions



A Bit More Explanation . . .

SCCT and Energy Efficiency Resources Serving As Reserves:

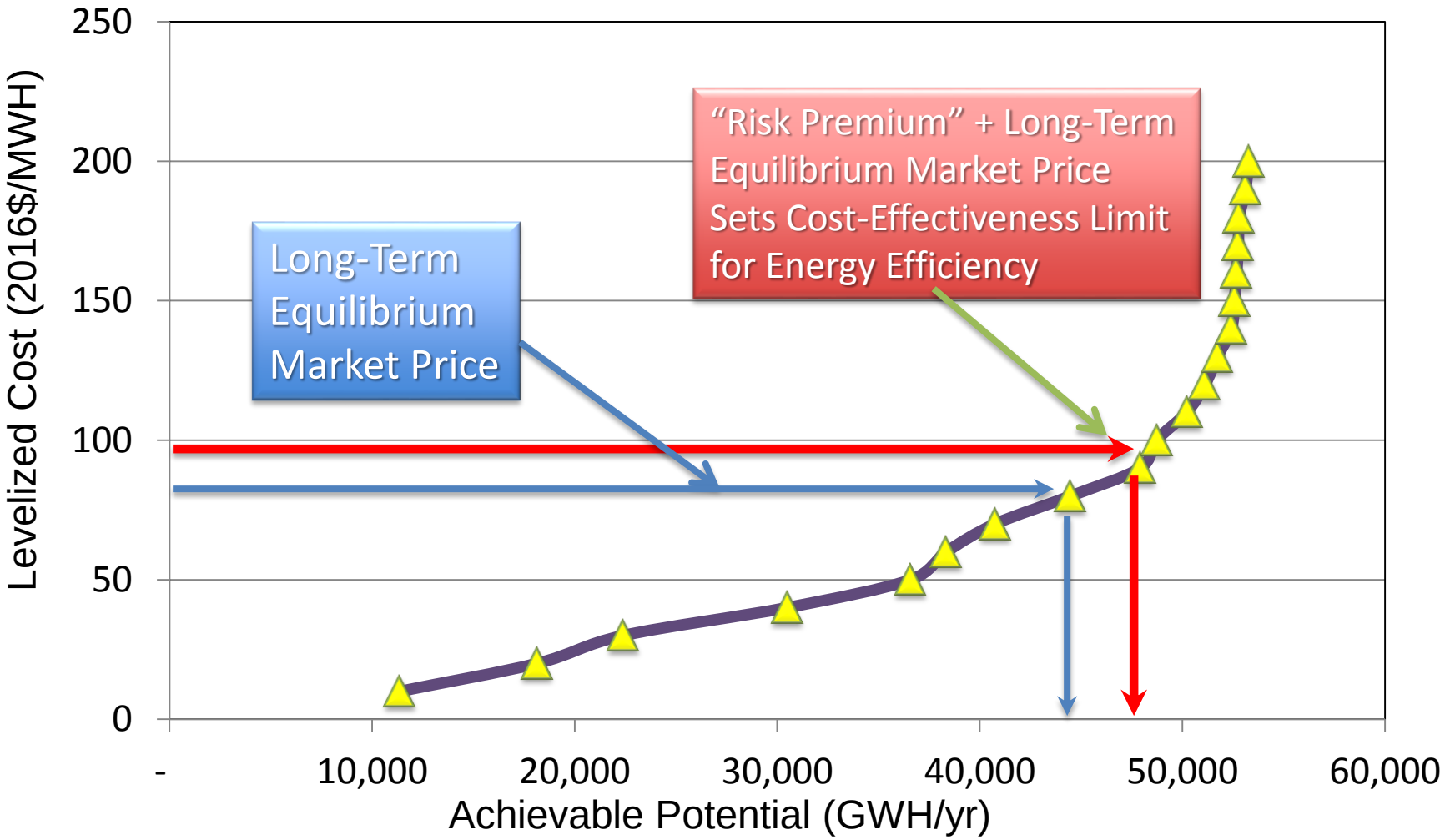
- Operate under circumstances of relatively lower electricity market prices and volatility
  - This is a direct consequence of having the additional resources that gives us protection against uncertainty (i.e., "we are *never* short")
- *Do not pay for themselves!*
  - If we want to reduce risk, we have to pay the insurance premium of extra capacity that may not be used frequently enough to cover its costs (i.e., reserves are "insurance" against unanticipated/unforseeable events).

Summary

- The quality of reserves provided by EE is superior to conventional resources, because:
  - EE *has value under low market prices*
  - EE is *not subject to forced outages*
  - EE is *not subject to fuel price risk*
  - EE is *not subject to carbon control risk*

- Implication - For low-risk plans, the cost-effectiveness limit for energy efficiency resources is higher than long-term view of the average wholesale market price for electricity

Setting A Cost-Effectiveness Limit Above Short-Term Market Prices, Acquires More Efficiency (Increases Reserves) and Reduces Both System Cost and Risk



Parting Shot

"The essence of risk management lies in maximizing the areas where we have some control over the outcome while minimizing the areas where we have absolutely no control over the outcome and the linkage between effect and cause is hidden from us." (emphasis is the author's)

--Peter L. Bernstein, ***Against the Gods, The Remarkable Story of Risk***

Any Questions?

Resources

- Binz, Ron, Sedano, R., Furey, D. and Mullen, D. Practicing Risk-Aware Electricity Regulation: What Every State Regulator Needs to Know. CERES 2012. Available at: http://www.ceres.org/resources/reports/practicing-risk-aware-electricity-regulation/view
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- Northwest Power and Conservation Council. "Overview of the Council's Power Planning Methods." Council Document 2011-02. Available at: www.nwcouncil.org/media/29998/2011_02.pdf.
- Northwest Power and Conservation Council. Fifth Northwest Power and Conservation Plan, Chapter 6 – *Risk Assessment and Management*. Available at: https://www.nwcouncil.org/media/5786/_06__Risk_Section.pdf and Appendix P, *Treatment of Uncertainty and Risk.* Available at: https://www.nwcouncil.org/media/4401598/AppendixP.pdf
- SEE Action. "Using Integrated Resource Planning to Encourage Investment in Cost-Effective Energy Efficiency Measures." DOE/EE-0668. Driving Ratepayer-Funded Efficiency through Regulatory Policies Working Group. J. Shenot, Regulatory Assistance Project. Available at: https://www4.eere.energy.gov/seeaction/system/files/documents/ratepayer_efficiency_irpportfoliomanagement.pdf.

Lunch Break

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Session 2 - Risk and Uncertainty Backup Slides

Definition of Terms

- *Uncertainty*: Imperfect information, or events about which we have imperfect information
- *Risk*: The likelihood and magnitude of "bad" ***outcomes***
  - This ***is not*** volatility; this ***is not*** uncertainty
  - Some uncertainties do not create risk
- *Futures*: Combinations of uncertainty aspects about the future that we cannot control
- *Plans*: Actions or policies that we can control
- *Scenario*: How a particular plan (what we control) performs under a particular future (what we don't control)

Definition of Terms - Risk Mitigation

- Options.
  - *The right, but not the obligation* to take a particular action or engage in a particular transaction.
  - Has two sides, and must be traded between participants.
  - Usually asymmetric with respect to a given risk: limits outcome in a single direction.
- Hedging.
  - *Commitment to action or transaction* that reduces the variability or uncertainty of outcome. Does not provide optionality.
  - Usually symmetric with respect to a given risk: limits outcome in both directions.
- Neither in itself decreases expected costs.

Risk Mitigation: Optionality

- Long-term flexibility
  - Start-up and shut-down speed and flexibility
    - Demand reduction
  - Mothball and delay flexibility
  - Operational and administrative control, independence
  - Sizing flexibility (capital cost flexibility)
- Short-term flexibility
  - Dispatchability, if fixed cost component is small
  - Demand curtailment

Definition of Terms - Hedging

- Long-term hedges
  - Independence from fuel price
  - Resource diversity
  - High availability and proven technology
  - Reliable technology
  - Cash flow: how and when capital is committed (complex)
  - R&D
- Short-term hedges
  - Diversity of fuels
  - Reliability of resource and reduced maintenance