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January 13, 2004

MEMORANDUM

TO: Council Members

FROM: Michael Schilmoeller

SUBJECT: Fifth Power Plan -- Briefing on Decision Making Under Uncertainty

The Council's is required to periodically produce a regional conservation and electric power plan. The plan is to incorporate a 20-year demand forecast and a forecast of the resources needed to meet satisfy that demand. From the Council's first plan it has been recognized that the plan must cope with uncertainty and the risks that uncertainty implies. This plan is no different and, in fact, must cope with additional uncertainties beyond those addressed in earlier plans.

The enclosed presentation is the first of several presentations I will be making to the Council on choosing the resources that will comprise the power plan. Decision-making under uncertainty is central to our analysis of regional resource requirements.

This presentation is for background and information purposes only. I will not be asking the Council to make any decisions. My objective is to start the process of communicating staff's approach to the plan and solicit any questions or advise the Council may offer.

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Decision Making under Uncertainty

January 22, 2004

Michael Schilmoeller

Northwest Power and Conservation Council

Background

- The Council is charged with the responsibility to produce a document that identifies a 20-year resource plan for the Region
- A key element of the resource plan currently under development by the staff is the treatment of risk
- This is not a new idea. Detailed treatment of other sources of risk, primarily resource availability, power requirements, and level of hydro generation, has been an important element of prior Plans.

Issues in the Fifth Plan

The role of risk

- incentives for generation capacity
- price responsiveness of demand
- sustained investment in efficiency
- information for markets
- fish operations and power
- transmission and reliability
- resource diversity and distributed generation
- role of BPA
- global climate change

- lessons learned from 2000-2001

Overview

- The general problem of decision-making under uncertainty
- How we apply decision-making principles to the problem of power system planning
- **What kind of information does the Council need in order to choose a power plan?**

General Problem

- Consider the problem of advising your teenage son or daughter on the selection of transportation
- We will restrict ourselves to the economic aspects of this decision

Many Alternatives

- Public transportation
  - Bus
  - Cab
- Buying a car
  - New car? Used car?
  - Safety
  - Reliability
- Leasing a car
- Bicycle

What Determines Our Choice?

- Cost
- Expectations about use
- Risks
  - Chance of accidents
    - » Protection the car affords in the event
  - Likelihood and cost of breakdowns and repairs
  - Missed meetings or appointments

The Decision

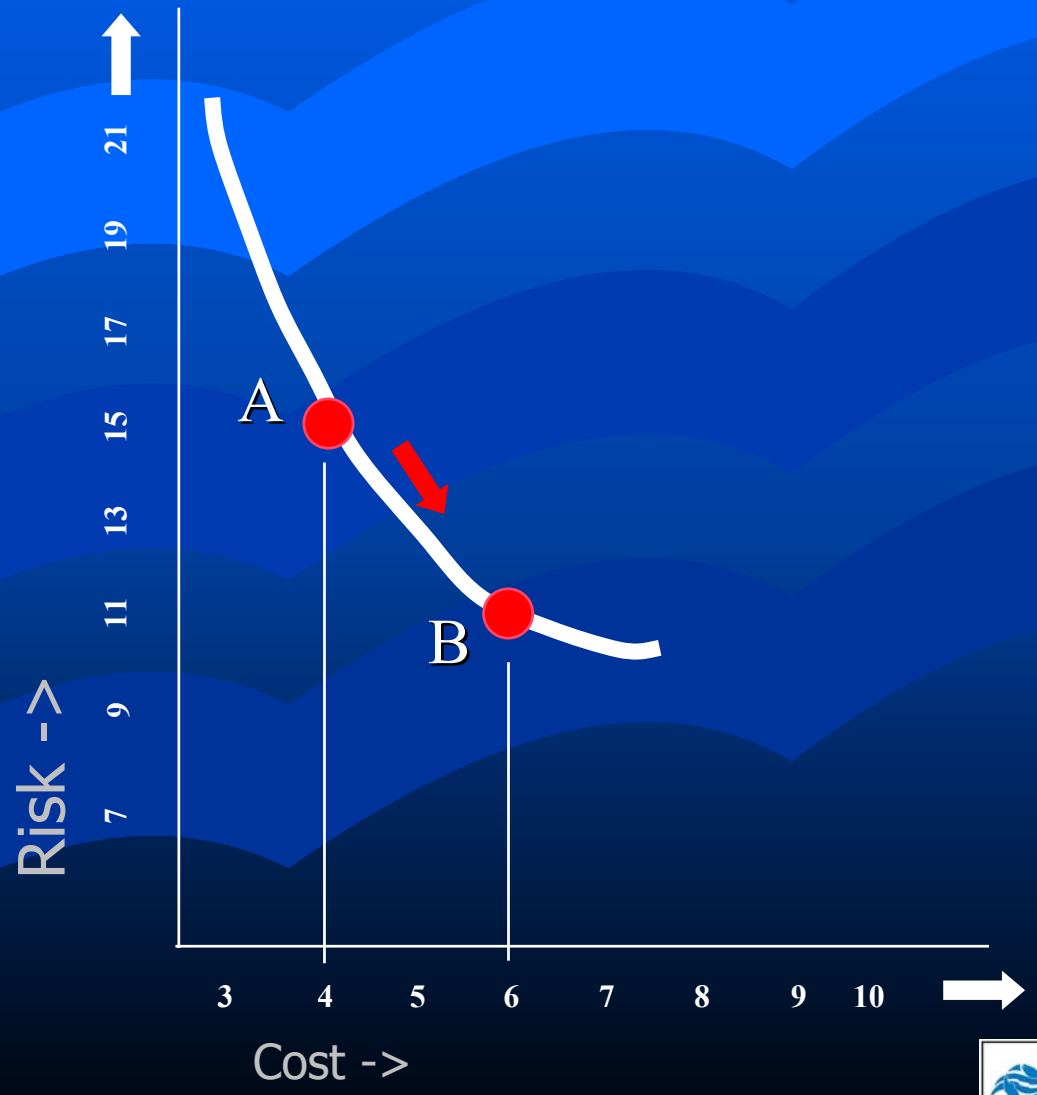
- For each choice of transportation, we can consider how that choice behaves in particular circumstances – possible "futures"
- We use our view of the likelihood of those circumstances to determine the attractiveness of that mode of transportation
- We try to avoid the bad outcomes, the "risks," and will generally pay a premium to help us avoid those outcomes

The Trade-off

- If we are willing to pay more, we can usually obtain greater assurance of avoiding bad outcomes
- For every level of risk we might be willing to incur, there is a least-cost (or most beneficial) mode of transport. We might as well restrict our decision to those least-cost alternatives.

The Trade-off

- The choice of transportation depends on how we weight the costs or benefits and the risk associated with that choice



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Decision Making

- These same concepts apply to the selection of power generation resources
- The Council will eventually need to achieve sufficient understanding of the trade-off of costs and risks to reach a recommendation for the 20-year resource plan that will appear in the Fifth Power Plan

Decision Making Terms

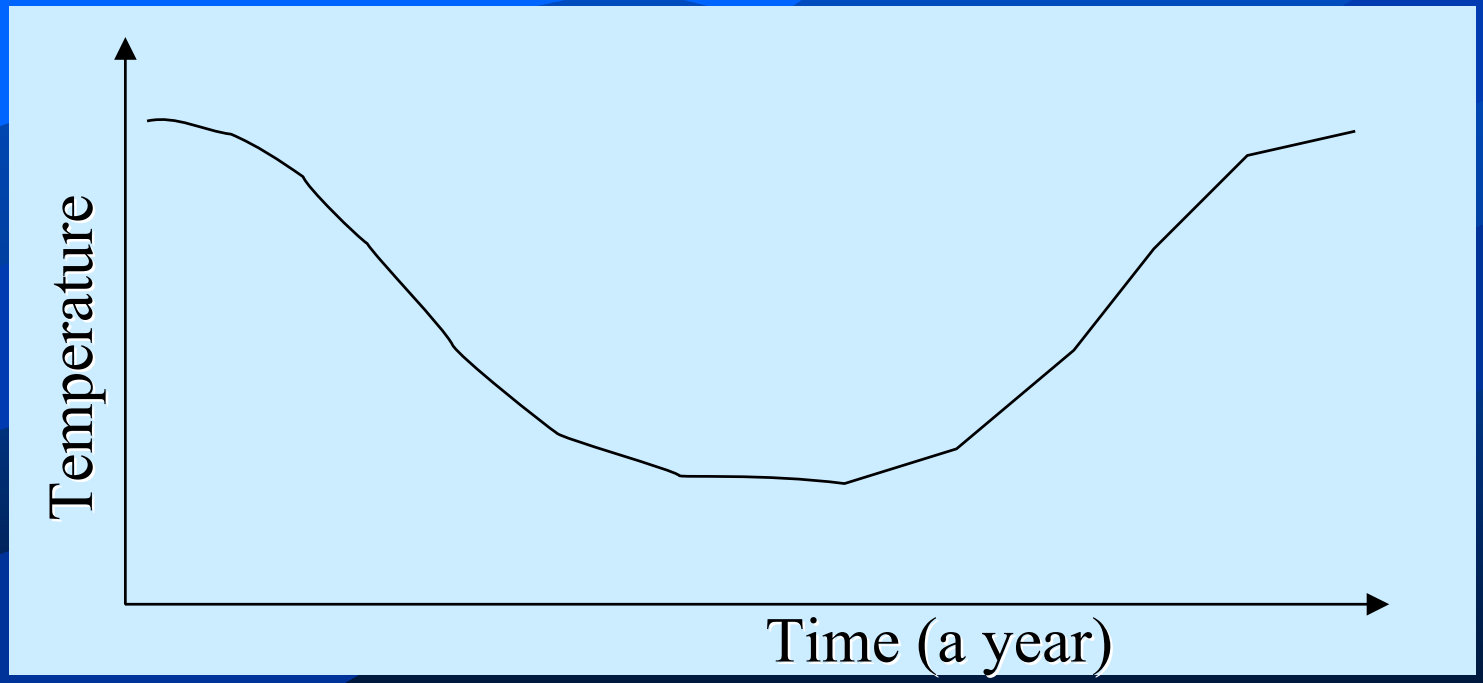
- Risk
  - A measure of bad outcomes
    - » Example: If an automobile collision occurs, what is the damage?
    - » Example: If a power system is unable to meet load, how bad is the outage?
    - » Example: If costs or rates have to increase, how high are the likely to go?
    - » Example: If stream flows are poor, what impact would we expect it to have on fish and wildlife?

Decision Making Terms

- Variation
  - Normal changes in outcome, which may be highly predictable
    - » Example: Rush hour traffic
    - » Example: Seasonal changes in price of natural gas
    - » Example: Daily temperature variation over the year

Decision Making Terms

- An example of variation is average daily temperature over the course of a year



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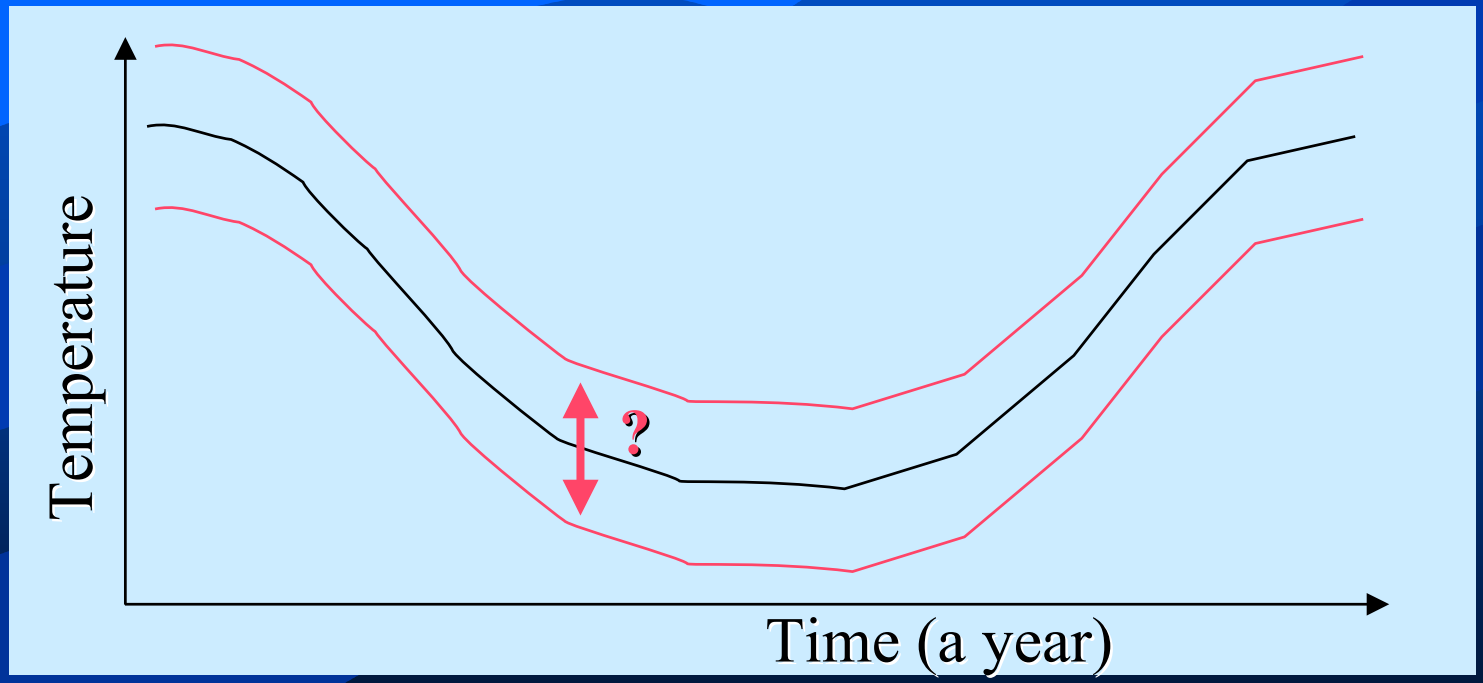
Decision Making Terms

- Uncertainty
  - The predictability of all outcomes
    - » Example: Commute time at rush hour on a particular day
    - » Example: Average commute time from Lake Oswego to Portland in 2015
    - » Example: Daily temperature on a particular day

Decision Making Terms

- For any particular day, the uncertainty in daily temperature can be large.



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Decision Making Terms

- Plans
  - Future actions we can control
    - » Example: buy a 1978 Toyota Corolla
    - » Example: install conservation instead of a gas turbine
- Futures
  - Future situations we can not control
    - » Example: A automobile crash in the local intersection
    - » Example: Electric power demand falls
- Scenarios
  - Combinations of Plans and Futures
    - » Example: How did your Toyota fare in the crash?
    - » Example: How are your costs affected with conservation?

Overview

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Futures

- Behavior for key variables
  - Power requirements
  - Natural gas price
  - Hydro generation
  - Electricity market price
  - Aluminum price
  - CO2 tax
  - Power plant availability
- Variation and uncertainty, including jumps and complex paths; relationships among these

Plans

- Specific recommendations, capacity and timing, for new additions over the next 20 years
  - CCCT
  - SCCT
  - Conservation
  - Price Responsive Demand
  - Wind
  - Coal

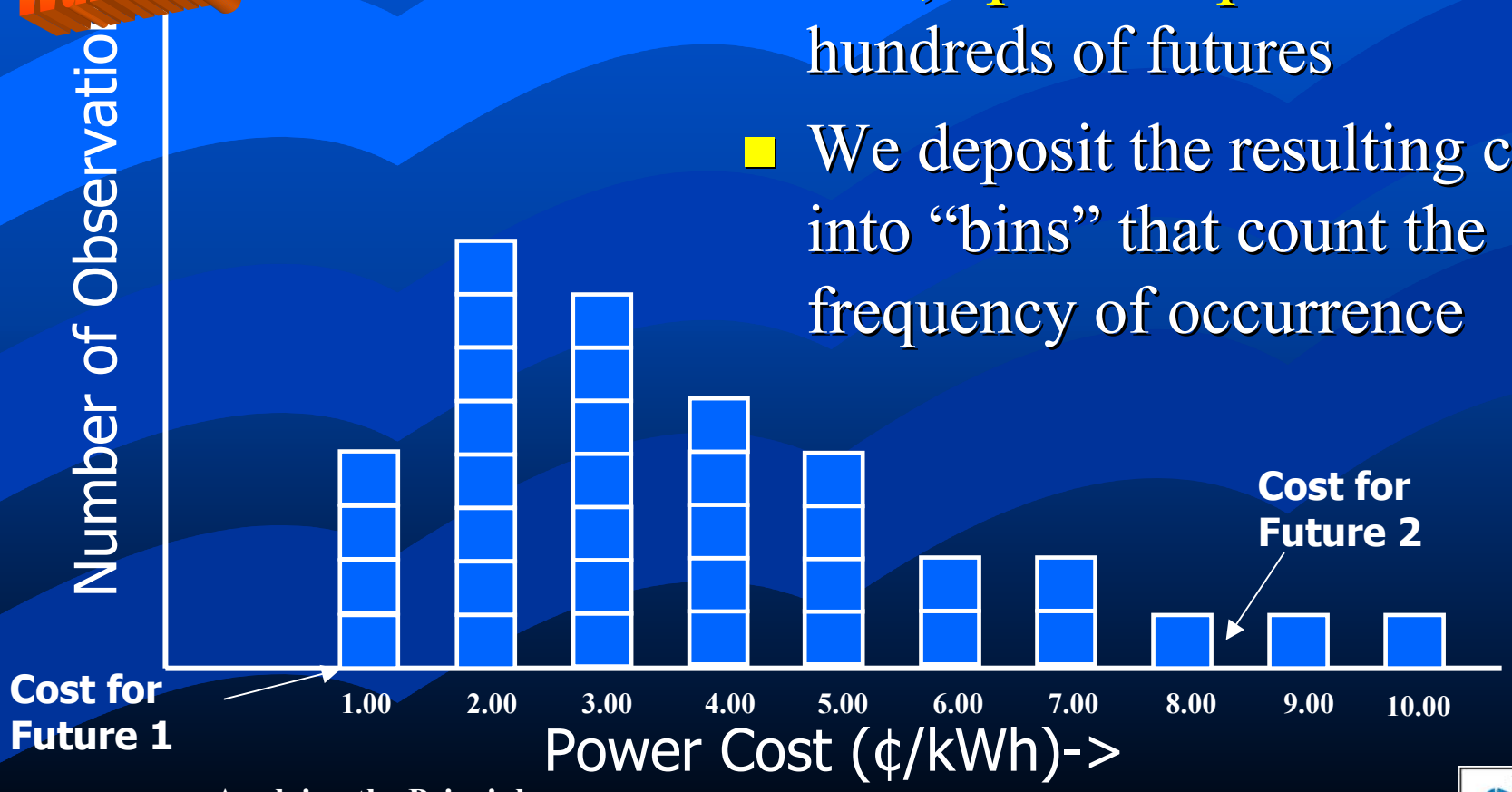
Example of a Particular Plan

	2005	2006	2007	2008	2009	2016	2021
Conservation (MW)	75	75	75	75	150	150	150
CCCT (MW)	0	500	500	1,000	1,000	1,000	3,000
SCCT (MW)	0	0	0	0	0	500	500
Coal (MW)	0	0	0	0	1,000	1,000	1,000
PRD (MW)	500	1,000	1,500	1,500	1,500	1,500	1,500
Wind (MW)	100	200	300	400	800	1,500	1,700

Distributions and Risk

Warning: Animated Slide!

- We compute the costs for one, specific plan under hundreds of futures
- We deposit the resulting costs into "bins" that count the frequency of occurrence



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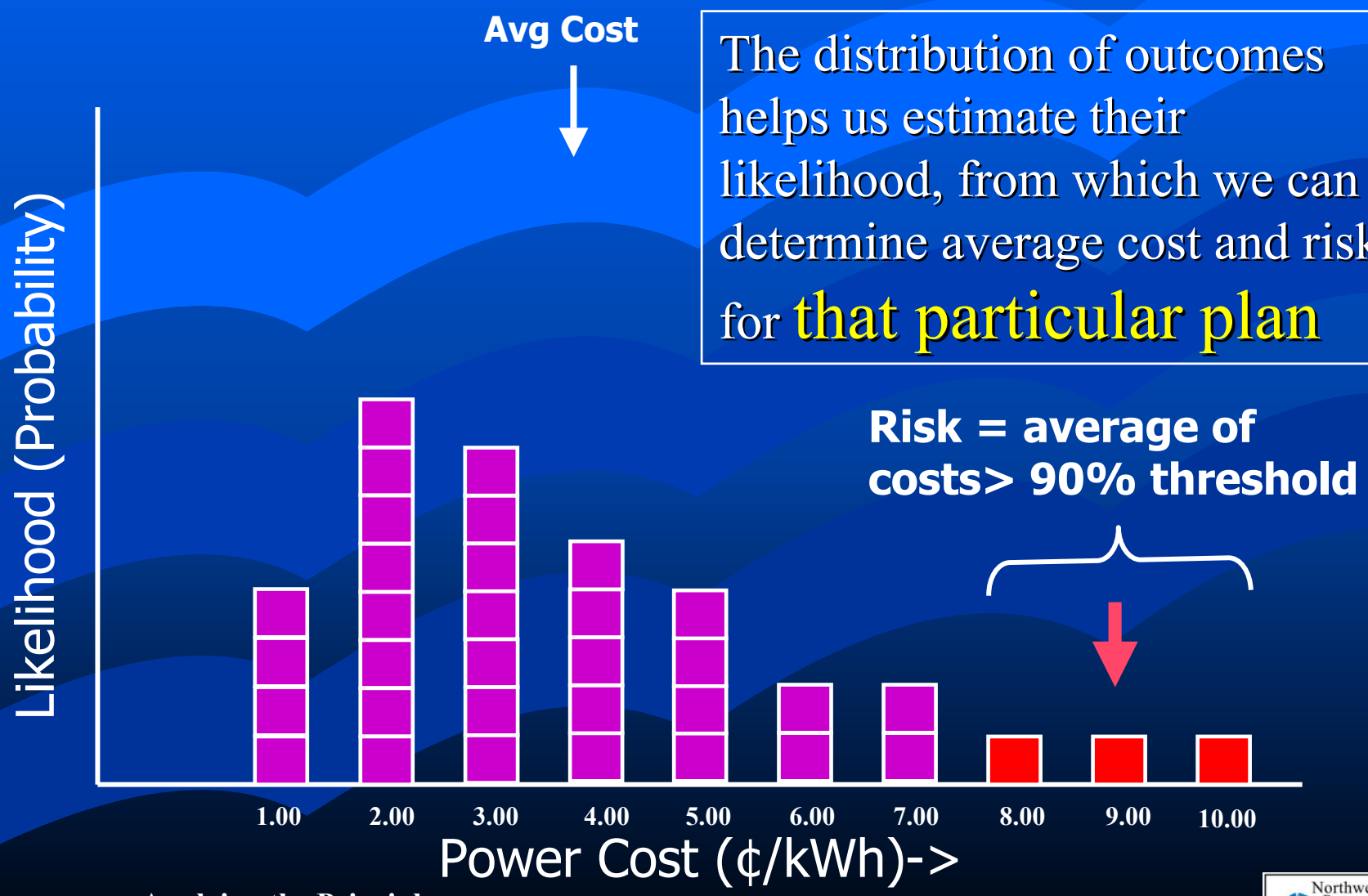
The Trade-Off

The distribution of outcomes helps us estimate their likelihood, from which we can determine average cost and risk for **that particular plan**



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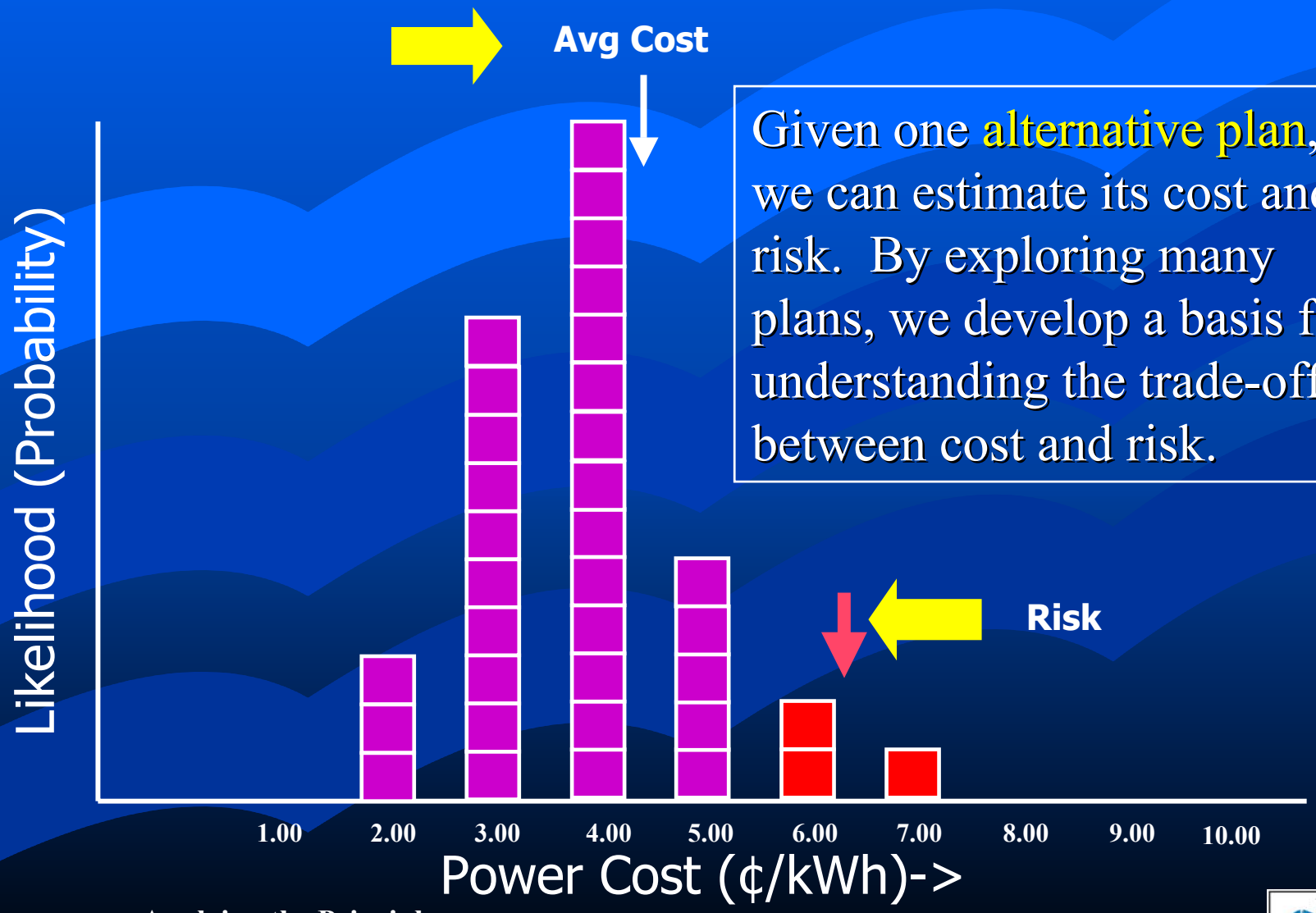
The Trade-Off



Given one alternative plan, we can estimate its cost and risk. By exploring many plans, we develop a basis for understanding the trade-off between cost and risk.

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Sources of Risk Mitigation: Hedging

- Committing to conservation in lieu of resources with fuel price uncertainty
- Entering fixed-price contracts for sale or purchase
- Entering fixed-price contracts for fuel price or source
- Building generation capacity, as opposed to relying on the market to cover contingencies

Sources of Risk Mitigation: Operating Flexibility

- Short-term flexibility afforded by *not* running a combustion turbine
- Tolling agreements (the right to exchange natural gas for electricity)
- The option to cancel a contract, probably incurring a penalty
- The option an industrial customer has to put load back on a provider
- Discretionary conservation programs

Sources of Risk Mitigation: Planning Flexibility

- Modularity (small size)
  - Reduces fixed-cost risk
  - Can more exactly match requirements
- Short Lead-Time
  - Can respond rapidly to opportunities or requirements
- Cost-effective Deferral
  - Usually available for only a limited time
- Cost-effective Cancellation
  - e.g., high salvage value or small capital commitment

Flexibility Has Value

- Flexibility was explicitly valued in the 1991 Plan with the ISAAC model
- The value of flexibility played a key role in the 2000-2001 as we saw load management and conservation respond to circumstances much faster and more effectively than conventional thermal supply-side resources. Generally, load exchange programs make this capacity a "reversible" resource.

An Approach To Answering Difficult Questions

- How much resource does the region need relative to its requirements?
- What is resource diversity?
- How do we evaluate whether the region has adequate resource diversity?
- How do we create incentive for new generation or other actions that will reduce the likelihood of another energy crisis?

Overview

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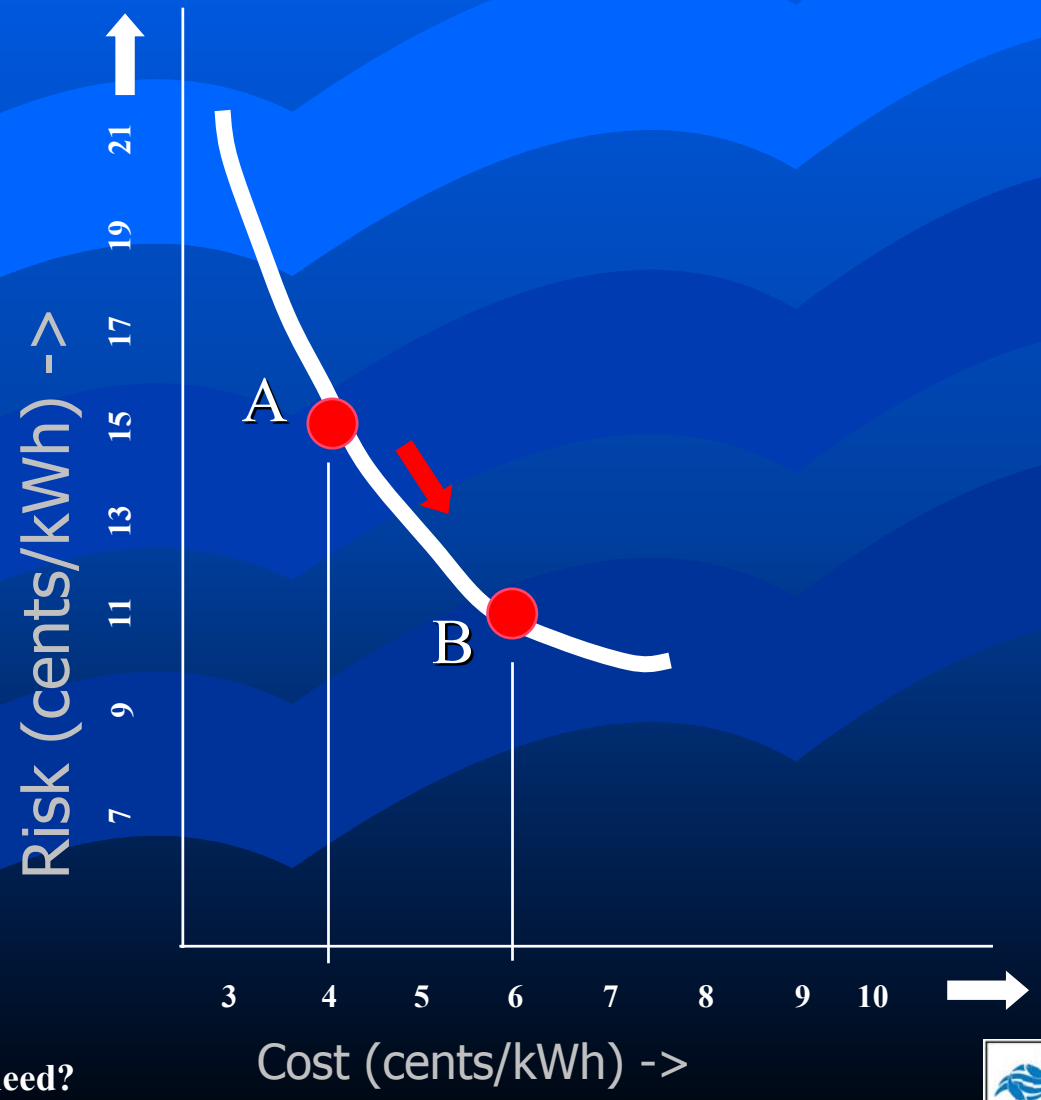
Recommendations

- More great presentations like this one!

Recommendations

- Basic information about the trade-off between cost and risk



 What does the Council need?

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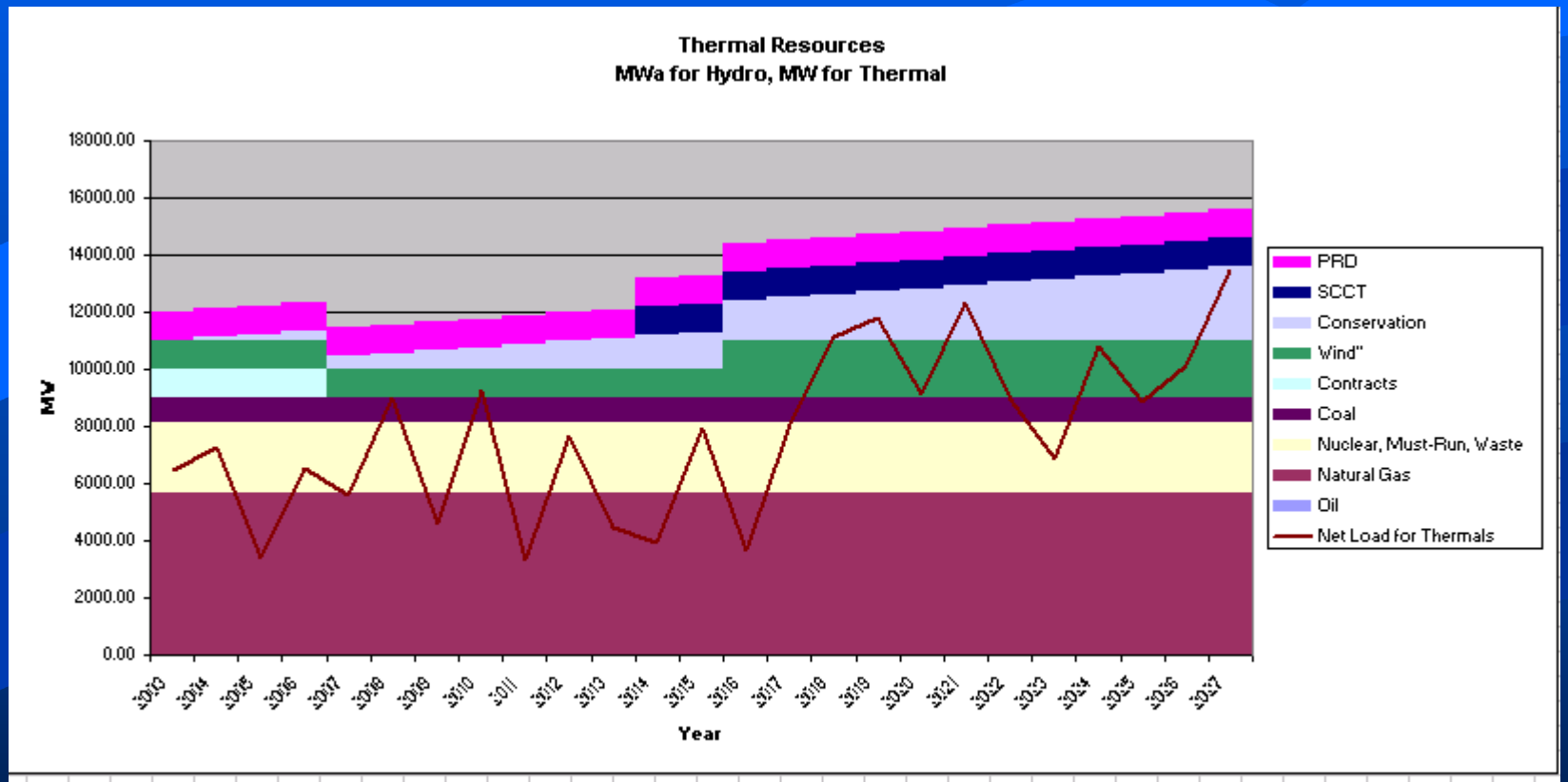
Recommendations

- Insights into
  - What a plan costs
  - How we expect it to perform
  - What the risks are
    - » How does the plan perform under specific futures?
    - » What are the chances we may see these futures?

Candidate Plan



Cost

Total Cost

What does the Council need?

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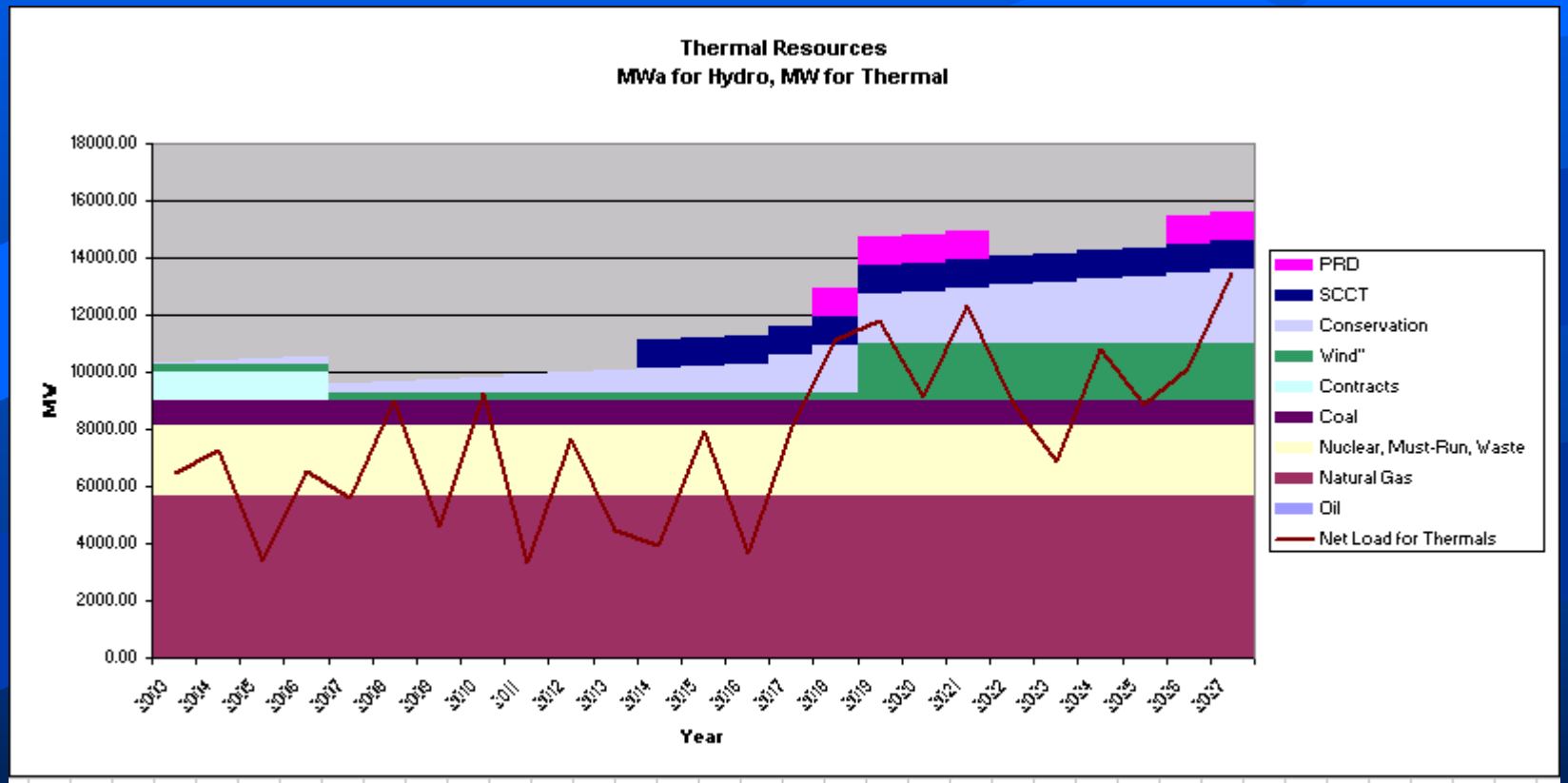
Candidate Plan



Cost	6.8	5.7	5.7	6.8	4.6	4.6	4.2	3.6	4.6	4.6	6.8	4.6	4.6	5.7	4.6	0.6	1.9	2.9	1.9	2.9	5.6	Total Cost 93

What does the Council need?

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Conclusions

- We make decisions under uncertainty every day. Many of the principles for evaluating resource plans are the same.
- We seek input on what the Council needs to know about resource planning decision.
  - Staff is preparing information on the costs and risks of specific resource plans
  - Staff intends to explain the risk management advantages of the proposed candidate plan in terms of the plan's ability to accommodate specific futures

End

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