MEMORANDUM

TO: Council members

FROM: Tom Eckman, Power Division Director

SUBJECT: Briefing on Power Planning Under Uncertainty

BACKGROUND:

Presenter: Tom Eckman

Summary: Staff will present an overview of Council’s approach to resource planning, focusing on how its analytical processes address the inherent uncertainty in major drivers of electricity demand, resource costs and risks. This is the second in a two-part series designed to provide Council members and interested stakeholders with background on the analytical methods used in plan development.

Relevance: The Council is engaged in the development of its 7th Power Plan. The product of that development process is a plan that represents the Council’s collective assessment of resource development and other actions that will “assure the Pacific Northwest of an adequate, efficient, economical and reliable power supply.”

Workplan: 1D - Prepare for Seventh Power Plan and maintain analytical capability

Background: In 1982, shortly after the Council was formed, Dr. Kai Lee, then a professor at the University of Washington and who later served as Washington Council member, authored a paper entitled, *The Path Along*
In his paper Dr. Lee described how the Council’s planning process departed from traditional utility power planning.

In the Council’s power plans there is an explicit recognition that the future is uncertain and that risk management strategies to deal with that uncertainty are needed. For example, until the Council’s first plan, utility resource planning was based on a single forecast of the region’s most likely energy demand. Resources that took ten or 15 years to build were planned and constructed to that best guess; if the future turned out differently, the region faced the problem of either having under built or overbuilt resources. The cost of error on either side was enormous.

The Council explicitly recognizes that the future cannot be predicted accurately and that uncertainty is a fact of life in power planning. To accommodate this problem, the Council has developed plans to meet a broad range of potential growth in energy demand, setting a boundary of high and low load growth forecasts over the next 20 years. The Council’s plans have also identified flexible resources such as conservation and options that shorten the lead time of generating resources.

This presentation will expand on the types of uncertainty the Council’s planning process must address as well as describe the analytical methods used by the Council to evaluate and identify resource strategies that can be used to mitigate risk at an acceptable cost.


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Planning for Uncertainty
An Introduction to the Council’s Power Planning Process

Tom Eckman
Director, Power Division
Northwest Power and Conservation Council
November 5, 2014
The Resource Planner’s Problem

- Don’t have too many resources
- Don’t have too few resources
- Have “just the right amount” of resources*

*Resources include energy, capacity, flexibility and other ancillary services needed for system reliability.
As A Utility’s Resource Mix Changes
So Does Its Cost and Risk

Exposure to Market Volatility
Exposure to Load Volatility

Resources
Loads

Firm Contracts/Resources
Market Purchases

The “Just Right” Resource Portfolio

Increasing Risk
Increasing Reserve Margin
Increasing Cost

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Increasing Firm Contracts/Resources Increases Load Volatility Risk

- **Exposure to Market Volatility**
- **Exposure to Load Volatility**
- **Over Supply**

**GWH/yr**

- **Resources**
- **Loads**

- **Firm Contracts/Resources/Loads**
- **Market Purchases**

**Increasing Risk**

- **Increasing Reserve Margin**

**Increasing Cost**
The Region Has Experienced Overbuilding

Total PNW Electric Loads (MWe)


3,700 MWe Forecasting “Error” Only Five Years in the Future


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Real World Example of the Cost of “Too Many Resources”

Wholesale Prices (BPA Rates) REALLY Increase (418% in real dollars over 5 years)
PNW Retail Electric Rates
1938 - 1985

Retail Electric Rates
REALLY Increase in Response to Thermal Plant Costs
Decreasing Firm Contracts/Resources Increases Market Risk...

- Exposure to Market Volatility
- Exposure to Load Volatility

Market Purchases

GWH/yr

Increasing risk

Increasing Reserve Margin

Increasing Cost

Resources

Loads

Firm Contracts/Resources/Loads

Market Purchases
The Region Has Also Experienced Underbuilding

During the mid-1990’s, Low Wholesale Market Prices Coupled With A Series of Above Average Water Years Led To An “Overexposure” to Market Prices
Real World Example of the Cost of “Too Few Resources”

PNW Retail Electric Rates 1985 - 2010

Retail Electric Rates Increase in Response to Over-Exposure to Short-Term Market

Nominal $ Cents/kWh  2006 $ Cents/kWh

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How The Council Addresses The

“Goldilocks” Problem?
First, We’ve Broken the Problem Into Six Simple Questions

1. When Will We Need Resources?
2. How Much Will We Need?
3. What Should We Build/Buy?
4. How Much Will It Cost?
5. What’s the Risk?
6. Who Can We Blame If We Get It Wrong?

(Answer – the Staff)
All Plans Require Assumptions About the Future

Perfect Foresight (i.e., *prescience*) is not possible.

However, it is an occupational hazard of planners!
Plan Must Address Three Major Sources of Uncertainty

1. Load Uncertainty
2. Resource Uncertainty
   - Output
   - Cost
   - Construction Lead Times
3. Wholesale Electricity Market Price Uncertainty
Load Uncertainty Is Particularly A Problem When Generating Resources Have Long Lead Times and Large Sizes

*Power Plant and Industrial Fuel Use Act of 1978 limited natural gas fired turbines run times to 1500 hours per year. (Repealed in 1987)
Generating Resource Long Lead Times Combined with Significant Load Uncertainty Created the Risk of Under and Over Building

~ 3700 MWa difference between NRF forecast and actual loads, only 5 yrs after forecast was done

Total PNW Electricity Use (aMW)


1960 Forecast 1965 Forecast 1970 Forecast
1975 Forecast 1980 Forecast Actual Loads

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Council Approach to Load Forecasting Assumes Lack of Perfect Foresight
(We Admit We Aren’t Prescient)

Plan 1 – Load Forecast Range

Regional Load (MWA)


- 1983 - Low
- 1983 Med-Low
- 1983 Med-High
- 1983 High
First Plan’s Response to Load Uncertainty

- Rely on efficiency due to lower cost, short lead times and ability to match development to scale of load growth
- Develop “options” on thermal projects with long lead times
  - Get the siting and licensing out of the way so that construction can commence when actual load growth requires development
Options Concept Was Designed to Address Load Uncertainty and Long Resource Development Cycles

Source: 1983 Northwest Power and Conservation Plan
Historical Levels of Load Uncertainty Were Often Driven by Large Industrial Load

PNW Direct Service Industry Load

Now, Not So Much
As A Result, Load Uncertainty Still Exists, But Near Term Volatility Is Lower

Increased Electricity Cost from West Coast “Energy Crisis” Resulting in Closure of PNW Aluminum Smelters and Other Industrial Facilities. Most of these smelters remain closed.
In Addition, Conservation and Shortened Lead Times and Smaller Sizes For Some Generating Resources Have Made Them More Flexible
Now, Short Lead Time, Smaller Resources Are Available, Reducing the Risk and Cost Mitigation Value of “Resource Optioning”

Source: 1983 Northwest Power and Conservation Plan
Plan Must Address Three Major Sources of Uncertainty

1. Load Uncertainty

2. Resource Uncertainty
   - Output
   - Cost
     - Construction Lead Times

3. Wholesale Electricity Market Price Uncertainty
Generating Resources Are Subject to Unanticipated Outages (i.e., “Forced Outages”) Which Reduces Their Availability

Generating Resource Forced Outage Rates by Resource Type

Unanticipated Forced Outage Rate (%)

- CCCT
- Coal
- Nuclear

2007
2008
2009
2010
2011

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SEVENTH NORTHWEST POWER PLAN

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Resource Variability Is Different Than Resource Uncertainty

But Both Are Important
Energy Efficiency Resource Uncertainty Stems from Delays in Deployment (i.e. Construction) Schedule

*Achievements reflect utility and NEEA savings only. Savings from codes and standards are included as baseline adjustments in each plan’s baseline load forecast*
Although This Source of Uncertainty Appears to be Diminishing
Since the West Coast Energy Crisis Actual Program Achievements Have Exceed Council Plan Goals

*Achievements reflect utility and NEEA savings only. Savings from codes and standards are included as baseline adjustments in each plan’s baseline load forecast.*
Resource Cost Uncertainty Is Driven by Input Fuel Prices and Utilization (i.e., “Capacity Factors”)

Lifecyle Cost of Combined Cycle Gas Fired Combustion Turbine at Varying Gas Prices and Capacity Factors

- Minimum Capacity Factor
- Average Capacity Factor
- Maximum Capacity Factor

Fuel Prices:
- $2.00/MMBtu
- $4.00/MMBtu
- $6.00/MMBtu
- $8.00/MMBtu

Real Levelized Cost (2006$/MWh)

Lifetime Capacity Factor

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Forecasting Natural Gas Prices Is Equivalent to Engaging in Commodity Trading

Which of these commodity price trends is natural gas?
Combined Cycle Generation Resource Capacity Factors Vary Significantly From Year-to-Year

Annual Capacity Factor vs. Combined Cycle Resource Number

- 2002
- 2003
- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010
- 2011
- 2012

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These Uncertainties Mean There’s No Single “Avoided Cost” for New Resources

Levelized Cost and In-Service Date of Combined Cycles Combustion Turbine Across A Sample of 6th Plan Futures
Plan Must Address Three Major Sources of Uncertainty

1. Load Uncertainty
2. Resource Uncertainty
   - Output
   - Cost
   - Construction Lead Times
3. Wholesale Electricity Market Price Uncertainty
Market Price Surprises - Electricity

Mid-C Wholesale Electricity Price (2006$/MWH)
Wholesale Electricity Market Prices Are Strongly Correlated to Natural Gas Prices

Mid C Wholesale Electricity Price

($/MWh 2012$)

Natural Gas Price ($/MMBtu 2012$)

- Historic Wgt Ave Mid C Price
- Forecast Mid Case
- Lin. Fit to Forecast data

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So Natural Gas Market Price Surprises Also Affect Wholesale Electricity Prices
With All These Uncertainties, How Does the Council Answer Those Simple Questions?

1. When Will We Need Resources?
2. How Much Will We Need?
3. What Should We Build/Buy?
4. How Much Will It Cost?
5. What’s the Risk?

The lowest cost, lowest risks resources first.
Almost

Resource Portfolio Analysis on One Slide

While the “All Resource Supply Curve” tells us what to acquire, it doesn’t tell us *how much, when, or the costs and risks* of acquisition!
The Answers to Those Questions Requires Planning for Uncertainty

**Resource Strategies** – actions and policies over which the decision maker *has control* that will affect the outcome of decisions

**Futures** – circumstances over which the decision maker *has no control* that will affect the outcome of decisions

**Scenarios** – Combinations of Resource Strategies and Futures used to “stress test” how well what we control performs in a world we don’t control

- Load Uncertainty
- Resource Uncertainty
  - Output
  - Cost
  - Construction Lead Times
- Wholesale Electricity Market Price Uncertainty
This Is What the Regional Portfolio Model Does

- **Electricity Demand Forecast**
- **Load Forecast Range** (without efficiency)
- **Units & Baseline Unit Use**
- **Energy Efficiency Resource Potential Assessment**
- **Energy Efficiency “Supply Curves”**
- **Generating Resource Cost & Availability**
- **Data to Create Futures**
- **Distributions of Key Drivers** (e.g., Fuel prices, wholesale market prices)

Council Reviews Cost and Risk of Alternative Resource Portfolios

Council Follows the “Gump” Resource Strategy Testing Model

The Future’s Like A Box of Chocolates.

You Never Know What You’re Gonna Get.
Council Portfolio Analysis Process “Test A Lot of Chocolates”
The RPM Finds the Lowest Cost “Insurance” for the Same Risk Coverage

<table>
<thead>
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<th>Policy year claim is filed</th>
<th>Low Deductible</th>
<th>Midrange Deductible</th>
<th>Higher Deductible</th>
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<td>$250 deductible</td>
<td>$500 deductible</td>
<td>$1,000 deductible</td>
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<tr>
<td></td>
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<tr>
<td>Springfield, CA</td>
<td>Insurance Provider 2</td>
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<td></td>
<td>Insurance Provider 3</td>
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<tr>
<td>Current Auto Insurance Payment: $154/mo.</td>
<td>$132/mo.</td>
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This image is for illustration purposes only, and do not necessarily represent the exact products, services, or ideas in the context they are found in.
What We Learn From “Stress Testing”
Alternative Resource Strategies Forms the Basis of “The Plan”

- Does the amount and pace of energy efficiency development change across “low cost” and “low risk” futures?
- How sensitive are resource strategies to assumptions regarding future carbon risk/prices?
- What resource strategies provide the greatest “hedge” against electricity and gas price uncertainty?
## Insights From Prior Plans

### Preferred Resource Characteristics

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>Low Cost</th>
<th>Short Lead Time</th>
<th>Small Increment</th>
<th>No or Low Fuel Price Risk</th>
<th>Low Carbon Policy Risk</th>
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</tbody>
</table>

🌟 = Resource exhibits desired characteristic
🌟🌟🌟🌟🌟 = Resource partially exhibits desired characteristics

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Your Task Is to Ensure that the 7th Plan’s Resource Strategy’s Benefits Outweigh Its Risks.
Any Questions?