Agenda

- Welcome
- Seventh Plan Timeline
- Identify Elements for CRAC Advice
- Lessons Learned from Sixth Plan
- Discussion of EE Policy Issues

Along the way we may identify technical analyses and sensitivity studies to develop as part of Seventh Plan.
Generic coal, gas and nuclear units are shown at typical project sizes - more units could be built at comparable cost.

Elements of Plan Development

- Economic & Demographic Forecasts
- Fuel Price Forecasts
- Conservation Programs and Costs
- Generating Resources and Costs

Demand Determinants
  - Residential
  - Commercial
  - Industrial
  - Irrigation

Total Electricity Use

Supply - Demand Balance

Resource Supply (Cost and Amount)

Realm of CRAC

Electricity Price
Other Council Advisory Committees

- Demand Forecasting
- Demand Response
- Generating Resources
- Natural Gas
- Systems Analysis
- Resource Adequacy
- Resource Strategies
- Conservation

Overview of Sixth Plan EE Methodology

1. Build Supply Curves
2. Schedule Availability
3. Adjust NLO Supply Curve for Program Deployment
4. Shape Savings by Season & Hi/Lo
5. Regional Portfolio Model
6. RPM Strategy for Least-Cost & Least-Risk
   - Cons Build-Out over 750 futures
   - Market Price Adder
7. Practical Considerations
   - Capability limits
   - Current conditions
   - Emerging efforts
   - Pending codes
   - Pending standards
8. Conservation Targets & Action Plan

Northwest Power and Conservation Council

**Measure Cost**
- Program Data
- Contractor Bids
- Retail Price Surveys

**Measure Savings and Load Shape**
- End Use Load Research
- Engineering Models
- Billing History Analysis
- Independent Testing Labs

**Measure Lifetime**
- Evaluations
- Census Data
- Manufacturers Data
- Engineering Estimates

**ProCost & Supply Curve Models**
- Provides stocks estimates for SC
- Modifies savings to reflect consumer price response
- Adjusts number of eligible units to reflect fuel choice

**Resource Portfolio Model**
- Determines measure and program level “cost-effectiveness” using:
  - Measure costs, savings & load shape
  - Aurora Market prices
  - T&D savings (losses & deferred $)
  - 10% Act Credit
  - Council Financial Assumptions (e.g. Discount Rate, Administrative costs, etc.)

**Aurora Model**
- Provides Forecast of Hourly Avoided Capacity & Energy Costs Under Average Water Conditions

**Plan’s Targets**

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Demand Forecast and Conservation Interface

**Demand Forecast**
- Price effect
- Frozen efficiency
- Sales

**Cost-Effective Cons.**

**Conservation Potential Assessment Model**

**Resource Portfolio Model**

**Other Supply Resource Options**

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Key Elements for CRAC Advice
Over Development of 7P

- Performance cost & availability
  - Inputs for costs & savings analysis
  - Shape of savings for capacity analysis
- Baselines & remaining potential
  - Technical & achievable potential
- Development assumptions
  - Ramp rates, Max/Year, LO/NLO Supply, etc.
- EE development decision rules in RPM modeling
- Action Plan recommendations

Seventh Plan Draft Timeline

[Timeline diagram showing key milestones and dates]

Updated August 2013
Lessons Learned Sixth Plan

- Factors affecting conservation resource development
  - Cost & amount of lost-opportunity & non-lost opportunity EE
  - Wholesale market prices
  - Carbon cost/risk
  - Load growth
  - Acquisition ramp rate assumptions

- Sensitivity analysis
- Uncertainty analysis
- Market price adder for conservation cost-effectiveness
  - How it operates as a decision rule

6P Size and Shape of Conservation Supply Curves

- Achievable Potential by 2020 (MWh)
- Levelized Cost (2006$/MWh)

- All Sector Lost-Opportunity
- All Sector Non-Lost Opportunity
6P Two-Thirds of the 6th Plan’s Achievable Potential Cost Below <$40 MWH (TRC)

6th Plan’s Non-Linear Conservation Supply Curve Has Implications for Risk Mitigation Value of Conservation
6P Available Lost-Opportunity Conservation

Availability of Lost Opportunity

Lost Opp Sum of Meas @150MWh
Lost Opp Sum of Meas @120MWh
Lost Opp Sum of Meas @90MWh
Lost Opp Sum of Meas @60MWh
Mean Build Out Lost Opportunity
Lost Opportunity Targets from Calculator

6P Available Retrofit Conservation

Annual Availability for NLO

RPM-Modeled Max Annual Pace
Available from Supply Curve @ up to $50/MWh
Available from Supply Curve @ up to $70/MWh
Available from Supply Curve @ up to $110/MWh
6P Maximum Availability Over Time (Incremental)

Availability of LO & NLO Combined

- Market @ $20 LO @ $70 and NLO @ $50
- Market @ $30 LO @ $80 and NLO @ $60
- Market @ $40 LO @ $90 and NLO @ $70
- Market @ $50 LO @ $100 and NLO @ $80
- Market @ $60 LO @ $110 and NLO @ $90
- Market @ $70 LO @ $120 and NLO @ $100
- *Target

6P Shape of Savings (20-Year Achievable)

Average Seasonal Rate
High and Low Load Hour Conservation 2029 and < $100 per MWh

- High Load Hours
- Low Load Hours

Shape of Energy Influences Capacity Value of EE

Need Better Shape Data
The Resource Planner’s Problem

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

The Region Has Experienced Overbuilding

Economist REALLY Underestimated Consumer Response to Retail Rate Increases Due to Thermal Plant Construction and Termination Costs
Overbuilding Was (and for some) Continues to Be Costly

Wholesale Prices (BPA Rates) REALLY Increase (418% in real dollars over 5 years)

Lesson 1 - Overbuilding can be REALLY Expensive
PNW Retail Electric Rates 1938 - 1985

Retail Electric Rates REALLY Increase in Response to Thermal Plant Costs
The Region Has Also Experienced Underbuilding

During the mid-1990’s Low Wholesale Market Prices, Coupled With A Series of Above Average Water Lead To An “Overexposure” to Market Prices

Lesson 2 – Under-Building (reliance on the short term market) can be REALLY Expensive

Retail Electric Rates Increase in Response to Over-Exposure to Short-Term Market
Lesson 3: Acquiring Additional Energy
Efficiency Reduces both Cost and Risk

Efficient Frontier when cost effectiveness level for efficiency is wholesale electricity price, plus:
- $5/MWH Risk Premium for non-lost opportunity efficiency measures
- $10/MWH Risk Premium for lost-opportunity efficiency measures


- Efficiency’s value stems from “being there” when a shortage hits (high prices)
- Higher levels of efficiency (lower demands) provide more price moderation
Lesson 5: Both Least Cost and Least Risk Resource Portfolios Rely Heavily on Energy Efficiency

Lesson 7: Energy Efficiency Development Does Not Change Much with Climate Policy Assumptions

- $20 Carbon Price
- $100 Carbon Price
- Current Carbon Policy Case
- Least Risk Plan
- Least Cost Plan

Cumulative Efficiency Development (GWH/YR)

6P Lesson Learned from Conservation Uncertainty Analysis

- Analysis done after Sixth Plan
- Tested uncertain cost and price
- Findings:
  - Conservation market adders were unchanged
  - Average acquisition of conservation over the 20-year study period was unchanged
  - Additional wind generation was optioned
### Sixth Plan Cost-Effectiveness Findings: Premium Over Market Price

- Future power prices are not known
- Cannot know conservation avoided cost a priori
- Cannot know “economic” potential a priori
- So RPM tests avoided cost decision rules
- Test levels: “Apparent” market price plus premium
- “Apparent” market price proxy is last 5-year price
- Premiums tested in increments (plus 10, plus 20 ...)
- RPM finds the decision rule that best reduces system cost & risk: Buy up to apparent market price plus X
- Approach meant to mimic utility system decisions

### Planning for Uncertainty in an IRP

- **Plans** – 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. RPM uses 750 futures to stress test plans.
- **Scenarios** – Combinations of *Plans* and *Futures* used to “stress test” how well what we control performs in a world we don’t control
Costs Uncertain for All Resources

Generic coal, gas and nuclear units are shown at typical project sizes - more units could be built at comparable cost.

Example: Uncertain Combined Cycle Costs

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

Real Levelized Cost (2006$/MWh)

- $2.00/MMBtu
- $4.00/MMBtu
- $6.00/MMBtu

Lifetime Capacity Factor

- Min
- Ave
- Max
Sixth Plan EE Premium Findings

- **Lost-Opportunity Conservation:**
  - Market Price plus $50/MWh
- **Non-Lost-Opportunity Conservation:**
  - Market Price plus $80/MWh
  - Modified to Market Price plus $30/MWh

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How Cost-Effectiveness Premium Operates

- Works in conjunction with shape of supply curve
- Builds more EE when market prices are low
- Limits overbuild EE when prices are high
Setting A Cost-Effectiveness Limit Above Short-Term Market Prices, Acquires More Efficiency and Reduces Both System Cost and Risk

![Graph showing levelized cost vs. achievable potential](image1)

Illustrative Impact of Cost-Effectiveness Premium

![Graph showing acquisition rates with and without premium](image2)
6P EE Development Decision Rules

- Modeling conservation development decision making used in RPM
- Important area for CRAC advice
  1. Apparent Market Price
  2. Ramp Rates - Acceleration
  3. Maximum Rate Limits
  4. Buy “Up To” Behavior
     - Sampling Non-LO
     - Sticky Downward LO
  5. Incorporate Regional Act Credit
6P Apparent Market Price

- EE “Buy Up To” decisions made each quarter
- Apparent Market Price proxy in any quarter:
  - Rolling average MP past 20 quarters (5 Years)

Test Premium on 750 Market Price Futures
6P Ramp Rates & Maximum Rate Limits

- **Retrofit (NLO):**
  - Based on measure by measure acceleration rates
  - 160 MWa/Year Limit
  - Sample from supply curve to reflect cannot buy only cheapest first

- **Lost Opportunity (LO):**
  - Fan of Curves for every two years
    - Based on measure by measure acceleration rates
  - Sticky Downward
    - To reflect codes & standards not falling back

6P Ramp Rates

Use a Bottom-Up Approach to Estimate Penetration Rates

- **Estimate Annual Penetration Rates by Measure Bundle**
- **Distinguish Features that Impact Penetration Rate**
  - Complexity of Measures
  - Delivery Mechanisms & Decision Makers
  - Current Market Saturation
  - Equipment & Infrastructure Availability
  - Subject to Code or Standard
  - Size & Cost
- **(Annual Penetration Rate) x (Annual Units) x (Unit Savings)**
- **Then Sum of All Measure-Level Supply Curves by Year & Levelized Cost bin**
6P Penetration Rate “Families”

- **Lost-Opportunity**
  - Emerging Technology
  - LO Slow
  - LO Medium
  - LO Fast

- **Retrofit**
  - New Measure
  - In 20 Years
  - In 10 Years
  - In 5 Years

6P Family of Lost-Opportunity Penetration Rates

![Diagram showing annual lost-opportunity penetration rates for different categories over time.](image-url)
6P Family of Retrofit Penetration Rates

Annual Retrofit Penetration Rates

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Retro in 5  Retro in 10  Retro in 15  Retro in 20  New Measure Fast  New Measure Medium  New Measure Slow

6P Sampling the Discretionary Supply Curve

- **Problem:**
  - Can’t buy only cheap conservation first
  - Programs mix high and low-cost measures

- **Solution:**
  - Sample from the supply curve
  - Sample based on amount in each cost bin
  - And favor bins with cost less than $40/MWh
Animated Sampling Discretionary

Go to: Copy of Olivia Conservation 090428-Launch.xls

Resultant 6P Discretionary Supply Curve

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slide 49

slide 50
6P Lost Opportunity Supply Curve Suite

Lost-Opportunity Supply Curve by Year

- 2010
- 2012
- 2014
- 2016
- 2018
- 2020
- 2022
- 2024
- 2026
- 2028

6P Results of Sensitivity Analysis

- Value of going faster
  - Retro 220 MWa/Year & LO 12-Year Ramp Up
- Cost of going slower
  - Retro 100 MWa/Year & LO 20-Year Ramp Up
6P Efficient Frontiers for Conservation Sensitivities

6P Acquisition Rate Findings

- Maximum Achievable Pace is Very Important
- Faster annual pace reduces cost & risk
- Annual pace limits have dramatic effect on cost risk
- Lost-Opportunity commands high adder
  - $50/MWh over market price reduces risk along the frontier
- Retrofit commands lower adder
  - Abundant conservation at low cost ($30/MWh average)
  - $30/MWh over market reduces risk along the frontier
Incorporating Regional Act Credit

- Regional Act:
  - EE is cost-effective at 110% of generation cost
- Credit calculated as 10% of power system value
  - Value of energy based on single 20-year market price
  - Value of deferred transmission and distribution system expansion based on kW impacts of EE
- Credit is subtracted from levelized cost of energy in the conservation supply curves

Results of Decision Rules

Mean Build Out Annual

Discretionary
Lost-Opp
Sixth Plan Discretionary Conservation: Distribution of Build Out Futures with Cost Data Annotations

NLO Conservation Build Out for Least-Risk Plan

- 2022-2026 RPM is tapping higher cost bins to maintain 150 MWa per year in 90% of the futures
- 2010-2021 RPM is tapping $23/MWh cost bin consumed by 2021
- $50/MWh cost bin consumed by 2023
- $23/MWh cost bin consumed by 2024
- $80/MWh cost bin consumed by 2025

Sixth Plan Lost-Opportunity Conservation: Distribution of EE Build Out Futures

LO Conservation Build Out for Least-Risk Plan

- 2010-2021 RPM is tapping $23/MWh cost bin consumed by 2021
- $50/MWh cost bin consumed by 2023
- $80/MWh cost bin consumed by 2024
- $23/MWh cost bin consumed by 2024
- $80/MWh cost bin consumed by 2025
### 6P Deterministic Model Results

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### 6P Stochastic Model Results

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6P Impact of Conservation Acquisition Decision Rules on Total Acquisitions

Cost Effectiveness Premium
Deterministic Sources of Value

- Capacity deferral and displacement
  - Based on shape of energy saved – hour, day, month
  - Impact anticipated kW peaks & peak resource needs
  - Frees up flexible resources
- Reducing RPS obligations
- Potentially
  - Cost reduction even for surplus utilities
  - Opportunities to develop and resell
- Purchases at below-average prices
  - The “constant-dollar averaging effect”
6P Capacity “Hedge” Value of Conservation Compared to Gas Peaker

Both Cost & Shape Matter: When Savings Occur Relative to System Peaks

Need Better Shape Data

Cost Effectiveness Premium
Risk Mitigation Sources of Value

- “Strategic” risk mitigation
  – fuel price exposure
  – wholesale power prices
  – carbon risk
- Superiority in both low-market and high-market futures relative to fuel-based resources
- “Inverse elasticity” effect
Historically, the pace of utility efficiency development has been tied to short-term market conditions. The result has been a rollercoaster ride, with various responses to events such as the West Coast energy crisis, the PNW recession, and discussions about restructuring and surplus.

Modeled acquisition without a cost-effectiveness premium shows a different trend, reflecting annual efficiency acquisition and regional total (aMW).
Modeled Acquisition
With Cost-Effectiveness Premium

Smoothing Mr. Toad's Wild Ride!

Just the value of EE in the market would have saved the region $14.9 Billion!

Even if the energy crisis had not occurred, the market value would have saved the region $8.9 Billion.

Discussion