Council Conservation Resource Potential Assessment and Cost-Effectiveness Methodology

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Manager, Conservation Resources

Bonneville “Brown Bag” On I-937
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Overview of Methodology

- **Resource Potentials Assessment**
  - Determines technical availability, achievable potential & cost

- **IRP Analysis**
  - Determines cost-effectiveness level and “targets”
  - Compares all resources
  - Develops low-cost resources first
  - Results in resource acquisition plans
    » Targets & budgets & programs for conservation
Source for Methodology

- **Regional Act**
  - and Council interpretation of the Act

- **Bottom line**
  - Develop cost-effective resources first

- **Defines cost-effective conservation**
  - “…estimated incremental system cost no greater than that of the least-cost similarly reliable and available alternative measure or resource…”
Generic Methodology for Estimating Conservation Resource Potential & Targets

**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

**Supply Curves**
- Number of eligible units\(^*\)
  - savings per unit = aMW
- Lost-opportunity resources
- Non-lost opportunity resources

**PROCOST 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.)

**Market Price Model**
Provides forecast of Hourly Avoided Capacity & Energy Costs under Average Water Conditions

**Portfolio Model**
Determines NPV of Portfolios with Alternative Levels of Conservation vs Other Resources

**Plan’s Targets**
**Inputs to Resource Potentials Assessment Methodology**

### Availability
- Scope of measures
  - Technologies
  - Practices
- Applicability territory
  - Number of units
  - Units savings
- Achievable over time
  - Retrofit
  - Lost-Opportunity

### Costs
- Materials & labor
- Annual O&M
- Periodic Replacement
- Program Admin
- Financing costs
- Externalities
- Other non-electric
Results of Resource Potential Assessment Methodology

- Summarize availability & cost
  - Supply Curves
  - TRC levelized costs
    » All Costs (net of benefits) per kWh
  - Lost-Opportunity Supply Curve
  - Retrofit Supply Curve (Non-Lost-Op)
  - Availability timeline

- Apples to apples comparison
5th Plan’s Non Lost-Opportunity Supply Curve
5th Plan’s Lost-Opportunity Supply Curves
5th Plan’s Achievable Potential

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
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<tbody>
<tr>
<td>Non Lost Opportunity Resources</td>
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<td>Lost Opportunity</td>
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Share of Cost-Effective Potential

- Non Lost Opportunity Resources
- Lost Opportunity
- Total
IRP Methodology

- Supply Curves delivered to Portfolio Model
- Portfolio Model finds least cost & risk Plans
  - Plan is resource acquisition & option schedule
  - Includes both conservation & generation
  - Amounts & timing of acquisitions & options
- For conservation this includes
  - Lost-Opportunity schedule
  - Non-Lost-Opportunity schedule
  - A Cost-effectiveness threshold
IRP Methodology

- 5th Plan tested hundreds of Plans
- Against 750 futures
- Found Plans with low cost & risk
- Tested Alternative Conservation Deployment Schedules
- Regional Conservation Targets
  - Derived from Plans on low-cost low-risk front
Portfolio Analysis Determines How Much Energy Efficiency to Develop in the Face of Uncertainty

- Annual Load Growth Probability (%)
- Real Natural Gas Escalation Rate Probability (%)
- Nominal Annual Electricity Price Escalation Rate Probability (%)
- Carbon Tax Frequency Chart
  - Mean = $689
- Carbon Tax
  - $0 $6 $12 $18 $24 $30 $36
- NPV System Cost
  - $35,500 $36,000 $36,500 $37,000 $37,500
- Carbon Tax Implementation Date
- NPV System Risk (2004$ Millions)
  - $35,500 $36,000 $36,500 $37,000 $37,500
- NPV System Cost (2004$ Millions)
  - $23,500 $24,000 $24,500 $25,000
Plans Along the Efficient Frontier Permit Trade-Offs of Costs Against Risk

NPV System Cost (2004$ Millions) vs. NPV System Risk (2004$ Millions)

- Least Risk: $37,500
- Least Cost: $35,500

Northwest Power and Conservation Council
Annual Conservation Acquisitions in 5th Plan

- Non Lost Opportunity Resources
- Lost Opportunity

Annual Acquisition (MWa)

- 2005
- 2010
- 2015
- 2020
Pace of Conservation Deployment Matters

- Option 1 - Accelerated
- Option 2 - Sustained
- Option 3 - Status Quo

Savings (aMW) vs Year


Northwest Power and Conservation Council
Or . . .
Utilities Can Just Use the Utility Target Calculator

http://www.nwcouncil.org/energy/UtilityTargetCalc_v1_3.xls
Background Slides
Regional Act
Cost-Effectiveness
Conservation Measure Cost-Effectiveness
“Inputs and Outputs”

- ECM Costs, Savings, Load Shapes & Coincidence Factors
- Bulk Transmission System Benefits
- PNW Avoided Cost by Transmission Control Area
- Local Distribution System T&D Benefits
- Carbon Emissions Benefits
- Non-Energy Benefits
- Total Societal Value
- Local Distribution System Value
- Bulk Power System Value
- Aurora West Coast Market Price Forecast

ProCost
What’s A kWh Saved Worth?

Value of a kWh of savings depends

- Cost of power in the wholesale market during the time of day, day of week, month of the year and the year it is saved
- How many years it lasts
Plus ...
Other Values of Conservation

- Quantifiable Non-Energy Benefits
  - Water savings, maintenance labor

- Distribution system expansion deferral
  - Poles, wires, transformers, substations

- Transmission system expansion deferral
  - Bigger poles & wires

- Externalities: Like CO2 production

- Regional Act Credit of 10% to conservation
Why Value Conservation at Wholesale Market Prices?

- Price paid to buy or sell the marginal kWh, or “run” the marginal resource
- At any given time, the marginal resource may or may not be a new power plant
- Conservation often displaces older generation out of the region
- Conservation defers new coal, wind, solar and gas generation
Timing-Based Value

Shape of Savings

Value of Wholesale Power

Value of kWh Saved

\[ \text{Value of kWh Saved} = \text{Value of Wholesale Power} \times \text{Shape of Savings} \]
Council 5th Plan Forecast of Future Average Monthly Market Prices
(Mid C-Trading Hub)

Monthly Average Market Price (2000$/MWh)

Jan-05  Jan-10  Jan-15  Jan-20  Jan-25
Typical “On-Peak” Load Profiles

- Res. Space Heating
- Res. Central AC
- Irrg. Agriculture
- Commerical HVAC

Percent of Annual Use

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec
Forecast On-Peak Market Power Prices by Month and Year

Wholesale Market Power Price (Mid C -$/MWh 2000$)

- 2005
- 2010
- 2015
- 2020
- 2025

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Typical Off-Peak Load Profiles

- Res. Space Heating
- Res. Central AC
- Irrg. Agriculture
- Commerical HVAC

Per Cent of Annual Use

January February March April May June July August September October November December
Forecast Off-Peak Market Power Prices by Month and Year

Wholesale Market Power Price (Mid C - $/MWh 2000$)

- 2005
- 2010
- 2015
- 2020
- 2025

Jan    Feb    Mar    Apr    May    Jun    Jul    Aug    Sep    Oct    Nov    Dec
The Council’s Conservation’s Cost-Effectiveness Analysis Compares Savings with Forecast Market Prices at the time the savings occur

- Four “Load Segments” are used to compute the value of savings:
  - Weekday “Peak” Load Hours
  - Weekday “Ramp Up/Ramp Down” hours and “Weekend Peak” Load Hours
  - Weekday and “Weekend Off-Peak” hours
  - Weekend and Holiday “Very-Low”
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Each Conservation Measure Has a Different “Cost-Effectiveness” Limit Based on When It’s Savings Occur

- **Weighted Average Value of Space Heating Savings** = $41/MWh
- **Weighted Average Value of Space Cooling Savings** = $78/MWh
Value Depends on Shape of Savings

Present Value of One kWh Energy Saved
Assuming a 20-Year Measure Life
But ...

Longer-Lived Measures Have More Value

Present Value of One kWh Saved
For Life of Measure - Energy Value Only

Present Value of Measure Energy Benefits
PV One kWh of Energy For Measure Life

<table>
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<tr>
<th>Measure</th>
<th>PV Benefit $/kWh Energy Saved (Year 2000$)</th>
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<tr>
<td>Residential Weatherization</td>
<td>$0.90</td>
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<tr>
<td>Small Commercial Air Conditioning</td>
<td>$0.70</td>
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<td>Energy Star Clothes Washer</td>
<td>$0.45</td>
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<td>Efficient Street Light</td>
<td>$0.20</td>
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<tr>
<td>Residential CFL</td>
<td>$0.10</td>
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Year:
- Residential Weatherization: 45
- Small Commercial Air Conditioning: 18
- Energy Star Clothes Washer: 14
- Efficient Street Light: 15
- Residential CFL: 6
Present Value of One KWh Saved Considering All Benefits

Present Value of Measure Benefits for Measure Life

PV Measure Benefit $/kWh (Year 2000$)

- Residential Weatherization
- Small Commercial Air Conditioning
- Energy Star Clothes Washer
- Efficient Street Light
- Residential CFL

Legend:
- Distribution Deferral
- Transmission Deferral
- Non-Energy Benefits
- CO2 Externality
- Regional Act Credit
- Wholesale kWh & Line Loses
Benefit/Cost Ratio

B/C Ratio = \frac{\text{Present Value All Benefits}}{\text{Present Value All Costs}}

- Incorporates all benefits
  - Shape of saved kWh, life of savings, transmission & distribution deferrals, non-energy benefits, quantifiable externalities
- Incorporates all costs
  - Capital & labor, O&M, periodic replacement, program admin & non-energy costs
  - Regardless of who pays
- Incorporates time value of money for both
- Good when greater than 1.0
Why We Use Benefit/Cost Ratio to Measure Conservation Cost-Effectiveness

- B/C ratio because timing of savings matters
- There is no single cost against which resources are measured
- All resources must now “compete” for development against the West Coast wholesale market price
- That price varies dramatically by time of day and season of the year

**Levelized cost was useful when we estimated the avoided cost as a single generating plant**
Why Cost-Effectiveness?

- Conservation reduces system costs when it is less expensive than alternative supplies
  - The bigger the difference the greater the value
  - No economic benefit to conservation that costs the same as alternative supplies

- Conservation reduces risk relative to some alternatives
  - It carries no risk of fuel or climate change cost
  - Reduces variability of loads
  - Has value even when market prices are low
The Act defines regional cost-effectiveness as follows:

- "Cost-effective", when applied to any measure or resource referred to in this chapter, means that such measure or resource must be forecast to be reliable and available within the time it is needed, and to meet or reduce the electric power demand, as determined by the Council or the Administrator, as appropriate, of the consumers of the customers at an estimated incremental system cost no greater than that of the least-cost similarly reliable and available alternative measure or resource, or any combination thereof.” (Emphasis added).
Under the Act the term "system cost" means:

- "An estimate of all direct costs of a measure or resource over its effective life, including, if applicable, the cost of distribution and transmission to the consumer, waste disposal costs, end-of-cycle costs, and fuel costs (including projected increases), and such quantifiable environmental costs and benefits as are directly attributable to such measure or resource"
Act Interpretation

- The Council has interpreted the Act’s provisions to mean that in order for a conservation measure to be cost-effective the discounted present value of all of the measure’s benefits should be compared to the discounted present value of all of its costs.

- This interpretation was adopted in the Council’s 1983 Plan and has not been modified.
Why Limit Utility Investments to Cost-effective Measures?

- **It’s Immoral** – Unless payments are limited by Rate Impact Measure/Test non-participant’s rates go up to subsidize others for savings that aren’t cost-effective

- **It’s Uneconomic** – Both the utility system and society could serve the same needs at a lower cost and money spent on non-cost effective measure reduces the amount available to secure these energy services from lower cost options

- **It’s Illegal** – Bonneville is restricted by the Act and both BPA and the region’s utilities are constrained by the Council’s model conservation standards for BPA and utility programs
Comparing Costs of Conservation & Alternatives

- **Levelized Cost**
  - Compare alternatives with different lifetimes & cash flow streams

- **Benefit/Cost Ratio**
  - Compare stream of benefits & costs
  - Use NPV to capture time value of costs & benefits

- **Perspectives**
  - Total Resource Cost Perspective (TRC)
  - Utility Perspective (UPC)
  - Bonneville Perspective
  - Customer Perspective
Resource Assessment Methods
(Availability & Cost)

- **Scope of measures**
  - Review known measures & practices
  - Over 130 measures & practices 5th Plan
  - New measures (technology)
  - Old measures die (codes supplant some)

- **Technical potential is**
  - Number of applicable units * Incremental savings per unit
Determine Measure Applicability
Account for territory-specific factors

- Fuel saturations (electric vs gas water heat)
- Building characteristics (size, vintage, insulation)
- Building use (retail, office, school ... single-family, multi-family, mobile home)
- System saturations (heat pump, zonal or gas heat)
- Equipment saturations (36 lamps per house)
- Current measure saturations (4 cfls/house)
- Measure life (stock turnover cycle)
- Measure substitution or overlap (either seal ducts on FAF **OR** convert FAF to HP and seal ducts)
Determine “Incremental” Savings per Applicable Unit

- Estimated kW & kWh savings
  - By time-of-day, day of week & month of year
- Savings over baseline efficiency
  - Baseline set by codes/standards or current practices
- Climate-sensitive
  - Heating & cooling degree days & solar
- Measure interactions estimated
  - Lighting & HVAC
  - Order of measures applied
Developing Costs

- Costs
  - Materials & labor
  - Financing costs
  - Annual O&M
  - Periodic Replacement
  - Program Admin
  - Externalities
  - Other non-electric

From programs, bids, published sources
If financed use sponsor’s cost
Lamp & ballast replacement costs
Marketing, staff,